

Distribution and Prevalence of Dermatophytes in Semi-Arid Region of India

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Abstract

Earth has been documented as a natural territory for fungi which cover individual kingdom with evolution. In subsequently vertebrates developed keratin which was a part of life as a structural aspect. Few moulds have skilled to digest keratin and crop up from soil and wastewater habitats. They take part as a keratinolytic agent in the purification of α -keratins with an incidence of disulphide and hydrogen bonds which are improperly biodegradable. The best moulds genera to decay of keratin are *Microsporum*, *Trichophyton* and *Epidermophyton*. The presences of these genera are open health issues in developing countries where they cause the mortal mycotic contagion. The reason behind this is perceived to be the poor hygienic environment and socioeconomic behaviour among people. The present review is a compilation of updated information concerning the nature of these keratinolytic moulds and abundances of most contributed developing countries including India.

Keywords

Moulds, Keratinophytes, Dermatophytes, Keratinase, Mycoses

1. Introduction

Soil has long been recognized as a natural habitat for certain fungi [1]. They differ from plants in the absence of chlorophyll and differ from bacteria in the presence of cell walls that contain either cellulose or chitin [2]. The forest, farmyard, park soils, as well as sediments of the rivers and oceans containing humus and organic material are the best candidate for growth of keratinolytic and saprophytic fungi. More than 100 species of fungi are gen-

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erally recognized as a pathogen for man found in soil [3]. Diseases caused by fungi, or Mycoses, can be clinically classified as superficial, deep, or systemic. Dermatophytes are the most important microorganisms, which cause superficial mycosis, and the lesions are characterized by circular disposition, desquamation, alopecia and erythema of the edges [4]-[6]. The dermatophytes have the capacity to invade keratinized tissue (skin, hair and nails) of humans and other animals to produce an infection, dermatophytosis, commonly referred to as ringworm [7] [8]. Dermatophytes are mycelial and keratinophilic fungi of the mold group, originally saprobial, but have adapted themselves to animal and human parasitism through evolution.

The Mycoses are caused by approximately 20 fungi, including dermatophytes, yeasts and non dermatophytes having the ability of parasitizing keratin rich tissues, which produce dermal inflammatory response and intense itching in addition to a cosmetically poor appearance [9]. The Mycoses caused by fungal infections of the skin and nails are widespread and the most numerous group amongst all Mycoses. During the last decades, mycotic infections are increased to more than 20% - 25% of the world's population. Their etiological agents and predominating anatomical infection patterns vary with geographical location and environmental and cultural factors [10]. Such fungi grow at surface temperatures of 25°C - 28°C with warm and humid conditions which is supported for infection on human skin. Infections by fungi are relatively common in tropical countries due to wearing of dirty and pungent clothing, low socioeconomic status, crowded living conditions, superficial skin infections, a low tendency to self limitation and poor medical care help to increase the epidemic spread of skin Mycoses. Also, booming tourism, international sports activities and increasing migration are responsible for disseminating an imported fungal group of Mycoses [11] [12].

Fungi have been categorized like an individual kingdom ever since the 1960s [13]. They embrace to yeast and moulds which are diverse in morphological and physiological appearance. They may populate sexually, asexually or both. These fungi are classified accordingly on the basis of stages in life cycle, the anamorphic and the telomorph states [5] [14]. The anamorph is the state where asexual or somatic reproduction occurs and has a distinct morphology, while on the other hand, teleomorph is the sexually reproductive (perfect) state, morphologically differentiated from the anamorph [15]. Asexual reproduction is perceived mostly in clinically encountered fungi. In Dermatophytic fungi, some species of *Microsporum* and *Trichophyton* genera potentially produced perfect stage of fungi as the ascumata with asci and ascospores through sexually reproduction [16]. This typical species are considered as teleomorphs and genus *Arthroderma* by Berkeley, 1860 with the discovery of *A. curreyi* [14]. According to them, principal species in *Microsporum* are known as *Nannizzia* while *Trichophyton* species are considered as *Arthroderma*, respectively [5] [17]. The perfect states have peridium of freely combine, thin-walled, light colored hyphae, which is an attribute of the *Arthrodermataceae*. Genus *Nannizzia* has thick-walled, aseptate, hyaline cells with one or more symmetrical constrictions [18].

According to Botanical taxonomy, the fungi are divided into four major divisions: *Zygomycota*, *Ascomycota*, *Basidiomycota* and *Deuteromycota*. Out of these, *Deuteromycota* is the most important group which has abundance account of pathogenic fungi. These fungi have septate hyphae and reproduce asexually by producing conidia [19]. From all pathogenic fungi, few have ability to penetrate the natural keratin and play a role as the keratinolytic agent. Emmons, (1934) was the first individual who sited to dermatophytes into three anamorphic (asexual, imperfect) genera, *Epidermophyton*, *Microsporum*, and *Trichophyton* at *Hyphomycetes* class of *Deuteromycota* phylum [20] [21]. These organisms are pathogenic members of the keratinophilic (keratin digesting) soil fungi. Few species of these genera also have the capability of reproducing sexually similar as Teleomorphic genus *Arthroderma* of the *Ascomycota* phylum [22]. This classification was updated with new species by several reviewers [5] [23]. On the basis of anamorphic morphology, two species in *Epidermophyton*, approximately 18 species in *Microsporum* and 25 species in *Trichophyton* are considered as members of these genera [24] [25]. The main features distinguishing the three dermatophytic genera are:

1.1. Epidermophyton

The *Epidermophyton* genus was firstly established by Sabouraud in 1910 with the invention of species *Epidermophyton rubrum* (*Epidermophyton interdigitale*—Kanfmam Wolf). These fungi have the capability to invade the epidermis but also have rare possibility against the hair. So, according to the new classification, this species are placed into *Trichophyton* genera named as *Trichophyton rubrum* [26]. Another species is *Epidermophyton floccosum* [14] [20] [25]. This one is entirely an Anthropophilic fungus which is the cause of a common human disease known as Tenia [27]. The causing ability of these genera is known as epidermophytosis. *Epidermophyton* is recognized by the existence of massive conidia which have thin walled and clustered branches [28]. The thick-

ness of the cell wall and shape varies depending on the species. Microconidia have Pyriform, about 2 - 3 μm [29].

1.2. Trichophyton

Trichophyton genus was identified by Malmsten in 1845 with the discovery of species *T. tonsurans* [26]. This genus produces smooth walled macroconidia and microconidia. Macroconidia have thin walled and cigar-shaped. Microconidia can be pyriform about 2 - 3 μm or irregular in form [25]. Members of the genus *Trichophyton* are the common agents of dermatophytosis [26]. They are especially significant in onychomycosis, but also invade the skin and hair, causing infection associated with substantial morbidity [30].

1.3. Microsporum

In 1843, Gruby was first named who identified *Microsporum* with the discovery of *M. audouinii*. The microscopically *Microsporum* fungus was confirmed at USA in 1956 [26]. The genus reproduces both micro- and macroconidia. Macroconidia are multiseptate, with thin or thick echinulate cell wall, spindle shaped and may be numerous or scarce [25] [27]. Causing by *Microsporum* is known as microsporiasis, usually produces a single inflammatory skin or scalp lesion [31].

2. Classification Based on Natural Habitat

Dermatophytes are classified into three habitual species as Anthropophilic, Zoophilic, and Geophilic species in an environment [12] [32] [33]. Their habitat depends on the survival host as human, animals and soil [34] [35]. They show diversity in the disease causing host range.

2.1. Anthropophilic

The Anthropophilic fungi are more prevalent among urban populations, principally in developed countries. In today's modern life, wearing slim shoes is in fashion which sustains warm humidity favourable for the growth of these fungi [10] [36] [37]. These typical dermatophytes are aggressive against human being's keratinized epidermis as precedence [13] [38]. They have rare occurrence of causing Tinea in animals [35]. In addition, their occurrence is superior in population with poor socioeconomic status. They spread direct or indirect commonly in schools, barracks, prisons through flooring, clothing, linens, furniture, barber shop instruments [13] [39] [40]. *E. floccosum* and *T. rubrum*, both pathogenic species are these customary fungi which lead to Tinea [5] [41] [42]. In *Microsporum* genera, essentially *M. audouinii*, *M. langeroni*, *M. rivalieri* and *M. ferrugineum*, *M. langeroni* have been categorized [14].

2.2. Zoophilic

These dermatogens habitually attack simply on the animal keratin substratum. This is their site of communication with human beings as host [43] [44]. The major reservoirs of these fungi are pets, farm animals, or wild animals [45]. Mainly dairy farming workers and children are at hazardous stage, which are in regular contact with farm animals, as well as wild animals [12] [46]. Pathogenic spores are hardly active as saprophytes but endure in a resting position on infected resources of an animal foundation [47]. In zoophilic species, mainly *M. canis*, *T. verrucosum*, *T. mentagrophytes*, *A. vanbreuseghemii*, *A. benhamiae* are widespread representatives which cause the mycosis disease in animals as well as human infection [48] [49].

2.3. Geophiles

These saprophytic dermatophytes are soil habitual fungi which disgrace to keratin as crude essence in nature [47]. These are pathogenic against human as well as animals [24] [25]. The presence of these typical dermatogens in nature is infected by natural factors as soil pH, temperature, humidity, environmental light, climate, chemical composition and amount of organic material in the soil [14] [50]. This group mainly consists of following members—*M. gypseum*, *T. ajelloi*, *T. terrestre*, *K. ajelloi* and *M. fulvum*.

3. Keratinase—Chemical Armory of Dermatophytes

Keratinase is a proteolytic enzyme involved in the crumbling of keratin [51]. Keratin is extremely strong pro-

teins which have elite properties as well as inflexible and hard [52]. Keratin has two key shapes, alpha-keratin and beta-keratin. Alpha-keratin is established in humans and other mammals while beta-keratin is present in birds and reptiles [1]. Few organisms are proficient to digest 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 [53]. The molecular mass of the keratinase enzymes ranges from 20 kDa to 60 kDa [54]. Certain strains of *Microsporum* and *Trichophyton* accumulate enzymes that dissolve the keratin and related fibrous proteins in hair, nails, skin, claws, feather, beak and hooves [55]. The extracellular keratinase produced by *Trichophyton* have 18 amino acids as alanine, aspartic acid, cysteine, glutamic acid, lysine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, proline, serine, threonine, tryptophan, tyrosine, and valine [56]-[58].

In primary infection of mycosis, arthroconidia adhere to keratinized surface. During epidermal surface infection, sparse fibrils make the relationship between fungal arthroconidia to keratinocytes. Even as inside skin level infection, novel produced arthroconidia illustrate thin and short appendices covering their whole shell. These then start to penetrate a larger contact area for greater relationship establishment between conidia and skin tissue [59] [60]. Adhesion of dermatophytes, release multiple serine-subtilisins and metallo-endoproteases (*fungalysins*) takes place, universally known as *keratinases* [61]. Clinically dermatophytes show diversity in substrate preference and invading to the stratum corneum of the skin, hair and nail [62]. After invading to skin by dermatophytes, fungal metabolic products disperse by malpighian stratum to derive Erythema and Pruritus [63].

Contagious infection concerning the skin and epidermal surfaces are perilous on the planet, especially in children due to lack of hygienic environment and education [64]. An essential group of these pathogens is fungi [65] [66]. Fungi are pathologically separated into two extensive groups by Clayton and Midgley in 1989. First are the dermatophytes, which have a natural group of morphologically and physiologically allied molds. They are usually causative agent of the disease ringworm or tinea [67] [68]. Another one is a miscellaneous group of distinct filamentous fungi which are known as saprophytes. These fungi can generate a variety of clinical infections of skin, hair and nails as Pityriasis versicolor, Erythrasma and Trichomycosis axillaris [40] [43] [69]. Pathogenic fungi are divided into four groups as:

3.1. Superficial

Superficial Mycoses is limited to the stratum corneum of the membrane and hair [59]. Essentially, Infection has induced no inflammation. The contagion is universally harassing the skin of youth people, particularly the chest, back, and upper and lower limbs of the body [64] [70]. Infection is encouraged by warm, humid environment and pitiable hygiene conditions all over the tropical and temperate regions of the earth [71]. In the superficial fungal contagion, each one dermatophytic mould constructs abundant or unusual characteristic pattern which is assumed as the causal agents. Superficial fungal infections are divided into 3 broad classes' as [72].

3.1.1. Dermatophytosis

The infections occur most only on dead Keratin at the top layer of the skin, hair and nails [73]. For example, *Tinea barbae* infects to the bearded area of the face, whereas *Tinea pedis* infects the foot [74]. The dermatophytes are mainly covered with infections to a single part of the body. *Tinea capitis* presents a significant endemic problem mainly in school children in the world [75]. The disease arises with settling separately on the skin, hairs, and nails in living beings [76] [77]. *Tinea* is the allusion of mycosis which presents as a considerable widespread problem generally in school children [75]. Among all *Tinea* implement, *Tinea pedis* is a universal infection, monitored in one in five adults. *Tinea cruris* cause crotch itch, crotch rot, eczema marginatum, gym itch, jock itch, jock rot. According to review of diseases of the foot 2003, 16 European countries have onychomycosis, as most frequent fungal infection in prevalence at 27% by *Tinea unguium*. *Tinea nigra* Disease also recognized as "Tinea nigra palmaris or plantaris is present as dark brown to black effortless patches on the palms of the hands and the soles of the feet" [78]-[83]. Dandruff (*Pityriasis capitis*) caused by *Pityriasis ovale* is another superficial dermatophytosis. This is a common chronic scalp condition marked by itching and flaking of the skin on the scalp [84]. The disease is commonly caused in billions immunocompromised persons by dermatophytes, yeast and non-dermatophytes agents [85].

3.1.2. Tinea Versicolor

This unique, superficial mycosis is a class of hygienic infection in adult beings. The characteristic symptom of

infection is skin depigmentation. The humid position is exterior of the body containing sebaceous glands at the upper trunk, neck & arms [64] [86].

3.1.3. Cutaneous Candidiasis

This classic mycosis is a type of skin infection generally caused by *C. albicans* [72] [87]-[89]. Infection occurs usually in the presence of warm, moist, and creased environmental areas such as the inguinal areas. *Candida albicans* is the innate Denizen of the mucous membranes of the genital, alimentary and upper respiratory tract of the host [90] [91]. The infection is located at the oropharynx, vagina and skin part of beings. Oropharyngeal and vulvo vaginal infections are usually recognized as thrush in women [92].

3.2. Subcutaneous

The subcutaneous Mycoses are infected through saprophytic fungi in nature [66] [93]. Infections are less aggressive than superficial contagion. Diseases are considered by a diverse group of infection that immediately gets dispersed into the keratinized dermis and tissue with presence of wounds [94] [95]. These invasive infections affect immune suppressed and transplanted patients also. The disease usually spreads gradually to next tissue and finally to the lymphatic [96]. Subcutaneous infections exist deeply amid in rural area's individuals [68]. Infections are restricted to the tropical and subtropical regions but Sporotrichosis are ubiquitous in the moderate region [97]. The common causes are Sporotrichosis, Chromoblastomycosis, Eumycotic Mycetoma and Hyalohyphomycosis [70].

3.3. Systemic Mycosis

The pathological fungi have a symbiotic parasitic association with lead infection resulting in establishment of disease in the host [98] [99]. The systemic infections are established in internal organs with entry through lungs, gastrointestinal tract and via intravenous routes [100]. The pathogenic agents of systemic mycosis are primary pathogenic fungi and opportunistic fungi. Primary Pathogenic Fungi are infected in pulmonary's basal and hilar division through respiratory path. During preliminary infection pathogens attack the lungs and then spread through various organelle division of the body. The primary infection includes Histoplasmosis, Blastomycosis, Coccidiomycosis and Paracoccidiomycosis [99] [101]. While opportunistic mycosis infections are caused by non pathogenic fungi with inherent virulence in immune-competent human host [102]. The causing morbidity increased in emergence of AIDS and cancer and post transplantation chemotherapy with more aggressiveness [103]. They cause infections through opportunistic fungi like Aspergillosis, Candidosis, Cryptococcosis [91] [99]. Other systemic infective agents are such as *Trichosporon*, *Fusarium* or *Penicillium*, which are non pathogenic fungi.

4. Ecological Status of Dermatophytes

Superficial infections are an open health issue in developing countries. Dermatophytes are proteolytic employer for the humiliation of keratin [51]. Few organisms are proficient to break it and arise from soil and wastewater habitats which participate as a keratinolytic factor in decaying α -keratins [53]. Several analytical researches have contributed work on the dermatophytic fungi around the earth [104] [105]. The superficial Mycoses infection was identified from 1845-1987. The outcomes were positive around 62.19% cases through direct KOH mounts [106]. The more popular keratinolytic fungi are incorporated with two bio-safety altitude as: BSL-1 and BSL-2. The BSL-2 fungi are actual dermatophytes posing a higher risk to man than the BSL-1 [107]. A Study was carried out to get information on the occurrence of fungi liable for superficial Mycoses in the region of Tripoli, Libya [108]. The outlets were having the Dermatophytes as *Malassezia furfur* and *Candida albicans*. Again In Libya, the prevalence of superficial mycosis has been studied [109]. The study was based on 2224 cases isolated from Dermatology Clinic at Tripoli Medical Center. And they founded presence of Tinea corporis in abundance through *Trichophyton violaceum*, *Trichophyton rubrum* and *Microsporum canis*. In Nigeria, a contribution on the prevalence of dermatophytosis and associated non-dermatophytes were carried out among Islamiyya school children of ages 5 - 13 years old [110]. The study, found the presence of disease up to 91% in children respectively. The majority infection is affected by *M. ferrugineum* upto 15.4%. The etiological agents have been isolated from The Gaza country which held ability to cause cutaneous mycosis. They detected the big prevalence of Tinea capitis, Tinea corporis and Tinea unguium infections respectively [69]. In Saudi Arabian's King Saud

University, keratinolytic geophilic fungi are screened by a mycological team. There identify eleven genera and 19 species. From that *Chrysosporium indicum* (33.75%) was the most available species [111]. About Korea, poultry farms are the biggest source for dermatophytes. These sources have huge amount of *Aspergillus* species [112]. Once again examined the hedgehogs in exotic pets in Korea and by then a 15 year old girl had been developed with *Tinea manuum*. The basic agent for that was *Trichophyton mentagrophytes* var. *erinacei*; a zoophilic fungus isolated [113].

In Mexico and Nezahualcoyotl City, the keratinophilic agents were isolated from pets. And they comparatively observed the presence in cat (67%) and dogs (45%) which represent the risk in contact persons [114]. The superficial fungal spores in socioeconomic persons were observed about 46.6% positive at AL-Yarmook Teaching Hospital containing abundance of *Pityriasis versicolor* [85].

In Bangladesh, reports suggested the increment in the clinical spectrum of disseminated fungal infections and malignancy. And they observed in the presence of deep Mycoses as Histoplasmosis, Blastomycosis, Mucormycosis and Pulmonary aspergilloma [115]. Once more, two more mycologists surveyed the dermatophytic infections and observed the highest prevalence of *Tinea corporis*, *T. Pedis*, *T. capitis*, and *T. unguium* in city. For these all major etiological agents were *Trichophyton* and *Microsporium*, *Epidermophyton* [116].

In Iran, a study had been conducted on onychomycosis and *Tinea pedis* caused by several dermatophytes. The outlets of the study confirmed the prevalence rate of both infections in Iran [117]. In Ahvaz, southwest part of Iran, especially in Ahvaz assessed the frequency of dermatophytic infection. Here researcher reported about the species *T. mentagrophytes*, *T. verrucosum*, *T. schoenleinii* and *M. gypseum* from this study. All these species are potentially pathogenic fungi [118]. Again north Iran's Gorgan region have a profusion of dermatophytosis which was evaluated. And this region had the *T. rubrum* and *E. floccosum* species as etiological agent [119]. In a comprehensive study of cattle dermatophytosis in Iran, firstly studied by Ghahfarokhi who discovered two infectives as *T. verrucosum* and *T. mentagrophytes* [120]. In Pak history, two different mycological researching teams appraised the dermatophytes at Sindh state, Karachi and Liaquat University of Medical and Health Sciences, Jamshoro where they identified the 23 species of keratinolytic fungi which have hazardous planet against Pakistanis [121] [122].

India, the developing country has four climates namely tropical wet, tropical dry, subtropical humid and Montane amongst the whole planet [123]. These climates perform to gain and sustain superficial Mycoses in human which is a public health problem [124]. The Indian subcontinent and close areas have a large number of ringworm infections throughout Delhi, Burla, Bangalore, Calcutta, Poona, Hyderabad, Lucknow, Jaipur, Madras citizens [125]. Several Indian mycologists have been reviewed and reported the mycosis in India [12] [126]. In the northern region of India, the presence of Onychomycosis was evaluated which is a chronic fungal infection of nails. In this investigation *T. mentagrophyte*, *T. rubrum* and *C. albicans* is a key agent for nail onychomycosis [127]. In Himachal Pradesh, the occurrence of dermatophytes was examined in hilly areas and achieved about eleven species from five genera. *Chrysosporium queenslandicum* (25%) and *C. tropicum* (19%) have a key presence in H. P. [128]. The Punjab region, inspected the infection of *Tinea capitis* among children of Ferozpur. Here infection of *Trichophyton violaceum* observed specially up to 65% clinically [129]. In M. P. the dermatophytes from humankind surface in Jabalpur have been isolated. The isolated genus was *Fusarium*, *Curvularia*, *Fumigatus*, *Aspergillus* and *Mucor*. All these have profusion in cellular protease production [130].

The north east region of India as Jharkhand has around 28% tribal communisms with contacting through piggeries and pork habitats. In Ranchi, *A. niger*, *F. oxysporum*, *P. chrysogenum*, *T. harzianum*, *T. reesei* and *A. alternata* that are important keratinolytic fungi were isolated [131]. In eastern India, Kolkata witnessed a study of prevalence of *Tinea capitis* conducted among urban school children. The common infection was observed as dull gray patches [132]. The increased level of relative humidity shows excellent growth. The bases of it, in the south of India contain large parameter for infection of dermatophytes due to humid nature. Various temperature systems (as 0°C - 50°C) and relative humidity (as 11.05% - 95.00%) were studied to evaluate the growth and sporulation of *T. mentagrophytes*, *T. rubrum*, *M. canis* and *M. gypseum*. Study of the occurrence and causative agents (fungus) of dermatophytosis was conducted in the Dermatology Section of Bharat Heavy Electrical Limited Hospital and Annal Gandhi Memorial Government Hospital, Tiruchirppalli, Tamilnadu, India [133]. With the sequence itself, Andhara Pradesh, recognized the Gulbarga district's humid environment for dermatophytes. And they observed clinical aetiological agents in great amount as *T. mentagrophytes*, *M. gypseum*, *T. tonsurans*, *E. floccosum*, *M. audouinii* and *T. violaceum* [134]. In Karnataka, estimated the clinical mycological status of *Tinea capitis* among children of urban population and the occurrence status of dermatophytes was 43% and

common agent was *T. rubrum* [135]. Similarly, Madhya Pradesh was surveyed in 1986-1987, which reported about presence of *T. rubrum* (64.5%), *T. mentagrophytes* (5.37%), *T. violaceum*, *E. floccum* (18.12%), *M. gypseum* (7.52%) and *M. nanum* [136].

The western regions of India have Thar Desert which plays a crucial role to attract moisture. By which the nature of region is dry tropical and subtropical. In this regard, the presence of dermatophytes in animals and firstly reported for *Dermatophilus congolensis* as a cause of dermatitis in humans, horse and antelope in College of Veterinary Science, Anand in Gujarat [137]. Again Baroda, observed 60.38% positive infection of dermatophytosis among Gujarati's population. *T. rubrum* was the main agent for *Tinea cruris* [124]. In the sequence, once again study is conducted on the frequency of superficial infection in Tertiary Care Hospital, Ahmadabad. They're found enormous amount of *Tinea corporis* infection caused by *T. mentagrophytes* in male than female up to 52.78% [138]. Mumbai has a busy life in the India. In Mumbai, reports on the occurrence of dermatophytes in five major public parks were shown. These parks enclosed eleven species as *Arthrographis kalrae*, *Auxarthron conjugatum*, *Chrysosporium indicum*, *C. queenslandicum*, *C. zonatum*, *Gymnascella dankaliensis*, *G. hyalinospora*, *Microsporium gypseum*, *Myriodontium keratinophilum*, *Trichophyton mentagrophytes* and *Uncinocarpus reesii* [139].

Rajasthan is the largest state, located in the northwest side of the Republic of India. Rajasthan is divided into 33 districts and seven divisions. It comprises most of the area of the large, inhospitable Thar Desert. Rajasthan covers 10.4% of India, an area of 342,239 square kilometers [140]. Jaipur is the capital and the largest city of the state. Temperatures can exceed 45°C in the summer months and drop below freezing in the winter. In Rajasthan three major districts are reviewed for dermatophytes by several mycologists [141]. The western part of Rajasthan, have a great amount of the Mycoses infections. In Jodhpur, the Sun City has been evaluated for the presence of dermatophytoses in the ruler hospital "Mathuradas Mathur Hospital" [142]. In South east part of Rajasthan, Kota districts have an atmospheric humid climate which is suitable for overgrowth of dermatophytes. In Kota, walk around in the presence of onychomycosis in citizens and observed 50.9% attendance of *Trichophyton* species including *T. tonsurans*, *T. rubrum* and *T. mentagrophytes* [143]. In the south western area of Rajasthan, examined the skin disorders in the child's community and resulted out up to 40.60% majority for Mycoses belonged to infection in Udaipur [144]. Again in a desert region, In Bikaner, the husbandry animals are studied for the presence of bovine dermatophytes. They've confirmed the presence of hyperkeratosis, hyperplasia, disintegration and acanthosis of epidermis, spongiosis and leukocytic infiltration of dermis developed by *T. verrucosum* [145].

The Jaipur district (capital) is located towards North-eastern area on Aravalli Hills of the Rajasthan in Northern India. Jaipur has a semi-arid climate receiving average daily temperatures of around 30°C and in the winter average temperatures ranging from 15°C - 18°C and with humidity. The climate of Jaipur promotes to the growth of dermatophytes, which are best studied at Rajasthan University by several mycologist. Among them, D. Williamson and M. Sharma started to diagnose the *Tinea* in Jaipur region from 1984. In 1995, Iyer et al. 1995 started to diagnose the dermatophytic scenario of Jaipur at clinical level. Their team have been founded the surveillance of *T. rubrum* and *T. mentagrophytes* up to 62.19%. Till 2008, Jain, Sharma and Saxena three dermatologists reviewed the dermatophytic infection in Jaipur. They are sampling from SMS hospital, Jaipur. In their results, *T. rubrum* was most predominant etiological agents in Jaipur citizens. *T. schoenleinii* (4.29%) was firstly isolated in this study. In the sequence of it, in 2010-2013, several local mycologists have been updating the clinical dermatophytic status in Jaipur profile [146]-[151]. Specially In 2011-2012, isolation of Dermatophytic agents was isolated firstly among the HIV positives in Jaipur [152]. Clinical investigation of Ringworm infection relevant to animal and human health was conducted at the Department of Microbiology, Apollo College of Veterinary Medicine, Agra Road and Jaipur. The aim of the study was to assess the frequency of dermatophytes infection on the skin of dogs in and around the Jaipur city [153].

5. Conclusion

From the above collected review literature, it can be concluded that Earth has natural territory for fungi with the evolution. It covers forest, farmyard, park soils, and sediments of the rivers and oceans around the world. These all entire habituates contain humus and organic material which are best growth factors for keratinolytic and saprophytic fungi. In nature, fungi occurs as anamorphic and telomorphic states by which they cause the Mycoses. These fungi are presented in environment as Anthropophilic, Zoophilic, and Geophilic species. There are about 20 fungi, including dermatophytes, yeasts and non dermatophytes having the ability of degrading the keratin rich

tissues. Infections by keratinolytic species are relatively common in developing countries due to wearing of dirty and pungent clothing, low socioeconomic status, crowded living conditions, a low tendency to self limitation, booming tourism, international sports activities, increasing migration and poor medical care which promotes to increase the epidemic spread of skin Mycoses. These dermatophytes are controlled by the utilization of compounds having 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. There is a possible prospect to search out new therapeutics as plants' remedies which generate natural drug against mycological disease.

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