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## Keratinophilic Fungi and their Distribution in India

SALIL SINGH

Assistant Professor, Vikram University, Ujjain (M.P.), India

### ABSTRACT

Keratinophilic fungi are a group of fungi that colonize various keratinous substrates degrading them to components of low molecular weight. These include a variety of filamentous fungi comprising mainly hyphomycetes and several other taxonomic groups. Hyphomycetes include dermatophytes and a variety of non-dermatophytic keratinophilic fungi. Most species of dermatophytes are anthropophilic or zoophilic in their natural habitat, while some occur in soil as saprophytes and are termed geophilic, for example, *Microsporium gypseum* and *Trichophyton terrestre*. Non-dermatophytic keratinophilic fungi, including species of *Chrysosporium* and other genera of fungi, are known to occur as saprobes in soil; some of them are potential pathogens of humans and animals. Studies on keratinophilic fungi of soils of varying habitats in different countries have demonstrated frequent occurrence of *Chrysosporium* spp and dermatophytes like *Microsporium gypseum* complex (*M. gypseum* and *M. fulvum*), *Trichophyton terrestre*, and *Trichophyton ajelloi*. Other dermatophytes known to occur infrequently or sporadically in soil in some countries are *M. cookei*, *M. vanbreuseghemi*, and *T. gloriae*, *Trichophyton simii*, *T. mentagrophytes*, *M. nanum* and *M. persicolor*, well-known zoophilic dermatophytes, have also been frequently recovered from soil in some countries including India.

KEYWORDS: keratinophilic, fungi, hyphomycetes, soil, countries, India, dermatophytes, saprophytes, pathogens

### I. INTRODUCTION

The term dermatophyte is a label used for three types of keratinophilic fungi responsible for the majority of fungal skin infections in humans. The three genera, *Trichophyton*, *Microsporium*, and *Epidermophyton*, together comprising about 40 different species, can be transmitted in many different ways, including person-to-person contact, contact with geophilic organisms in the soil, spread via animal vector, and even indirectly through inanimate objects carrying the fungi. Infections are primarily localized to the hair, nails, and outer layers of the skin, reflecting the affinity of the fungi for keratin and the inability of the fungi to invade deeper tissues or organs in immunocompetent skin. Infections can cause a number of symptoms, including extensive inflammation, itching, and discolored, scaly skin lesions.

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Additionally, these fungi express a number of proteases, including elastase and keratinases, which likely contribute to the spread of the fungi within the skin by degrading substrates in the extracellular matrix.[1]

Treatment options for dermatophytoses depend on the location and extent of the infection. As such, topical antifungals are used to treat the majority of dermatophyte infections, although oral therapy is preferable for *Tinea capitis*, *Tinea barbae*, & *Tinea unguium*.

Keratinophilic fungi are natural colonizers of keratinic substrates. Some are keratinolytic and play an important ecological role in decomposing  $\alpha$ -keratins, the insoluble fibrous proteins. Because of the tight packing of their polypeptide chains in  $\alpha$ -helix structures and their linkage by disulphide bridges, they are poorly biodegradable. Two main forms of attack have been identified: surface erosion and radial penetration. In surface erosion, the sequence of degradation proceeds as the level of keratinisation (the cystine crosslinks) of the components of the keratinic matrix increases. In radial penetration, on the other hand, specialized hyphae can penetrate like a drill through the matrix, irrespective of the degree of keratinisation. This may illustrate how the growth can change direction and how secretory activity may concentrate at the tips of the penetrating hyphae.

The *Chrysosporium indicum*, *C. tropicum*, were found to be the most common isolates in cattle farm soil samples. The *Microsporium gypseum* a well known geophilic dermatophyte was also one of the most frequently isolated species from the soil. In addition to this some of the isolates of saprophytic molds, belonging to the species of *Aspergillus*, *Acremonium*, *Alternaria*, *Fusarium* and *Malbranchea aurantiaca* grew on the hair-baits used in soil samples. The predominant keratinophilic fungi reported in most of the samples include *Chrysosporium spp* (*C. indicum*, *C. tropicum* and the dermatophytes *M. gypseum*). In addition, zoophilic dermatophytic fungus (*T. mentagrophytes*) was also isolated from the soil samples in India.

**Table 1 Keratinophilic fungi from soils of different cattle farm /yards and houses in India**

No.	Name of the Fungi	1	2	3	4	5	%
1	<i>Aspergillus fumigatus</i>	1	2	-	2	3	8
2	<i>A. flavus</i>	2	1	1	-	1	5
3	<i>A. niger</i>	1	1	1	1	-	4
4	<i>A. Terreus</i>	1	2	1	2	1	7
5	<i>Acremonium sp.</i>	1	1	-	1	1	4
6	<i>Alternaria sp.</i>	+	2	-	1	2	5
7	<i>Chrysosporium indicum</i>	1	2	1	2	2	8
8	<i>Chrysosporium tropicum</i>	1	3	1	3	2	10
9	<i>Curvularia lunata</i>	1	1	-	1	1	4
10	<i>Fusarium oxysporium</i>	1	2	1	1	3	8
11	<i>Humicola insolense</i>	1	1	-	1	-	3
12	<i>Microsporium gypseum</i>	1	3	1	3	2	10
13	<i>Malbranchea aurantiaca</i>	1	1	-	-	1	3
14	<i>Penicillium sp.</i>	1	2	1	1	-	5
15	<i>Paecilomyces variotii</i>	1	1	1	-	-	3
16	<i>Trichophyton rubrum</i>	-	1	1	1	1	4
17	<i>T. mentagrophyte</i>	1	2	1	1	1	6
18	<i>Scytalidium sp.</i>	1	2	-	-	2	5

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Total	17	30	11	21	23	102
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## II. DISCUSSION

Keratinophilic fungi are an ecologically important group of fungi that cycle one of the most abundant and highly stable animal proteins on earth - keratin. This article briefly explains how to isolate and identify them, the process of keratin degradation, and the ecological role of this important but unnoticed group of minute keratin cycling machines present in soil. We believe that Indian soil contains many more such fungi which have not been isolated and we hope this article will create interest among students to isolate and study these interesting fungi. Sometime in the early history of vertebrates, as they evolved from life in water to life on land, they evolved a specialized protein known as keratin (from the Greek word for horn). This tough, fibrous, insoluble material provided an outer coat that served to prevent the loss of body fluids. Keratins have since proliferated into a wide variety of substances performing many different functions: the claws and armour of reptiles, the feather and beaks of birds, and the hooves, horns, skin, hair and nails of mammals.[6] Keratin is a scleroprotein and is mechanically hard and chemically unreactive, owing its strength to the numerous cross-links of disulfide bonds, which hold together the molecular chains of this protein. Due to the strength and stability of keratin, very few organisms are able to break it down and utilize it. Only a few insects, bacteria, actinomycetes and fungi can use keratin as a resource. Humans and other higher vertebrates cannot digest this protein, and if ingested, it just gets accumulated in the form of a lump that remains undigested. A large part of tiger scat and other carnivore in India dung contains keratin (mainly hair) apart from bones and other indigestible elements.

Keratinophilic fungi are a group of environmentally and epidemiologically important fungi that cycle a recalcitrant animal protein known as keratin. A large group of keratinophilic fungi cause diseases in human and animal mycoses so called as dermatophytes. The present study was undertaken to evaluate the diversity and activity for the group of keratinophilic fungi from the humus of India. Keratin-degrading keratinophilic fungus was isolated from the humus collected from fresh water Indian lakes. [5] The isolated fungal strains were initially identified on the basis of macro- and microscopic characteristics and confirmed using molecular approach. Lakes in India along with soil and animal dungs are a significant reservoir of keratinophilic fungi which can pose a health risk to its users, particularly the tourists and the employees. The keratinolytic activity of these fungi is crucial to cause superficial infections in human and animals, and recycling of keratinic material of this atmosphere.[2]

Keratinophilic fungi play a vital role in nature in the breaking down and mineralization of keratinous substrate into simpler substances. Their ability to grow on keratin regarded them as pathogens to human and animals including livestock. For example, an invasive infection was noted in an 18-year old woman who was a bone marrow transplant recipient as *Chrysosporium*, where the infection began as a facial swelling and extended into the central nervous system. *Chrysosporium zonatum* was reported causing disseminated infection in a patient with chronic granulomatous disease. *Chrysosporium tropicum* was reported from comb lesion in two different breeds of chicken in India. Thus, these fungi may be regarded as “opportunistic” pathogens.[4]

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### III. RESULTS

Results of a preliminary survey carried out in India about the keratinophilic fungi associated with feathers of pigeon on high rise buildings in Thane district of Maharashtra (India) have been reported. A total of 100 samples were examined, of which 67 samples were positive for keratinophilic fungi. Altogether 67 fungal strains belonging to 10 species of seven genera were isolated viz. *Chrysosporium indicum* (24%), *Chrysosporium* sp. (2%), *Chr. tropicum* (8%), *Chrysosporium* state of *Arthroderma tuberculatum* (3%), *Chrysosporium* state of *Ctenomyces serratus* (15%), *Malbranchea pulchella* (3%), *Malbranchea* sp. (1%), *Microsporum gypseum* (5%), *Myriodontium keratinophilum* (2%) and *Trichophyton terrestre* (4%). [3] Hence these fungi are associated to keratin and found in hair, nails, feathers, skin, soil, animal dung etc. We have seen various impacts of keratinophilic fungi in humans causing diseases like:-

### Fungal Diseases of Hair, Skin, and Nails



Mycoses

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Athlete's foot , ringworm, yeast infection etc



Keratinophilic fungi causing skin diseases

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## IV. CONCLUSIONS

The keratinophilic fungi are of prime importance in regard to various skin diseases prevalent in various areas. These fungi are able to utilize keratin, a fibrous protein, as sole carbon and nitrogen source and survive saprophytically in nature .[4] Many keratinophilic fungi frequently parasitize keratinous tissue, viz. skin, nails and hair in man and animals. Some of them share certain morphological features, constituting a special group called dermatophytes . The impact of keratinophilic fungi on human health seems unexplored part of various studies .Dermatophytes and other keratinophilic fungi have been isolated from various keratinized part of body in animals and human . Various keratinophilic fungi along with some dermatophytes are responsible for various skin infections, little epidemiological data on the fungal disease of skin in human is available . Knowledge of the frequency and extension of etiological agents of humans and animal mycosis and other potentially pathogenic fungi on the healthy hairs and nails of humans is of prime importance for understanding of epidemiological cycle of these fungi[7] .

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