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DISTRIBUTION OF KERATINOPHILIC FUNGI IN VARIOUS SOIL SAMPLES: A REVIEW

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Keratinophilic fungi present in soil which are responsible for the degradation of keratin containing wastes such as hair, fur, hoof and feather. Therefore Keratinophilic fungi plays significant role in decomposition of debris. The distribution of Keratinophilic fungi is highly variable, which depends largely on ecological conditions. We have also highlighted the role of these fungi in keratin degrading ability. Their substantial keratinolytic activity is highly appreciable in cleaning of environment.
Keywords: Decompose, Distribution, Keratin and Keratinophilic fungi, Soil fungi.

Introduction

Keratinophilic fungi are a specialized group of fungi that utilizes keratin as a rich-nutrient substrate containing complex nitrogenous material. The word keratinophillic means "keratin-loving". The distinction between keratinolytic and keratinophilic fungi is based on keratin usage or destruction. Kerationlytic fungi are a group of microorganisms able to decompose keratin remains in the environment and being potentially pathogenic to human and animals. Keratinolytic fungi are represented by dermatophytes and related species of the genus *Chrysosporium*. On the other hand, keratinophilic species only use material associated naturally with keratin or resulting from its destruction. Keratinophilic fungi are restricted to keratinous substrates like hair, nails, feathers and hoofs present in soil. The enrichment of soil with keratinous material is most conductive to the growth and occurrence of these fungi. With few exceptions almost all the keratinophilic fungi grow saprophytically on keratinous substrate. Keratinophilic fungi are present in environment with variable distribution patterns that depends on different factors such as human and animal presence.

The distribution of populations of keratinophilic fungi in natural environments is not uniform and mostly depends on pH differences. Keratinophilic fungi cannot be seen by the naked eye unlike other macro fungi. During the past few decades, a great interest has developed in medical mycology throughout the world with increasing studies on medical and veterinary epidemiology of dermatophytes. The saprophytic growth and survival of dermatophytes largely depends upon the keratinophilic ability, transition from saprophytes to the parasitic life style.

This paper attempts to review concisely the present state of knowledge of the distribution of different taxonomic group of keratinophilic fungi.

In 1839, French dermatologist Sabouraud postulated that dermatophytes are primarily soil saprophytes. Later, Szathmary (1936)[1] succeeded for the first time in isolating a dermatophyte (*Microsporum gypseum*) from the soil. Vanbreuseghem (1952)[2] introduced the simple and efficient "*To- Ka-Va hair bait technique*" for the isolation of keratinophilic fungi from soil. This method was used in different parts of the world for the isolation of keratinophilic fungi and to study the geographical

distribution, ecology, pathogenicity and taxonomy of this interesting group of fungi. In 1955, *Microsporum* was isolated for the first time as a Keratinophilic fungus from soil by Dey and Kakoti in 1955[3]. By the end of Sixties, work on isolation of Keratinophilic fungi from soil samples had begun almost all over the world as is evident by the reports of Rogers and Beneke from Brasilian soil[4]. Baxter from Britain[5], Mercantini *et al.* from Italy[6] and Mohapatra and Ghosh from Srilanka[7].

Franca and Caretta (1984)[8] reported some keratinophilic fungi from the air at Pavia. During the investigation a total of 375 colonies were recorded, from which it was possible to identify 32 species representing 22 genera. Chabasse and Cimon investigated Keratinophilic fungi from 60 soil samples of kindergarten and secondary schools in Italy[9]. Ogbonna and Pugh (1987)[10] reported Keratinophilic fungi from Nigerian soil. These fungi had a higher incidence of occurrence of individual species during the rainy season than in the dry season. Guarro *et al*. recorded keratiniphilic fungus, by hair bait method from soil in Spain[11]. Chabasse (1988)[12] studied 272 soil samples collected from public parks and gardens of Angers, France and isolated 1091 strains of keratinophilic fungi from variety of sites during three years study. Ali-Shtayeh *et al.* in 1989 isolated Keratinophilic fungi from the dust of the floor and soil samples in schools in the West Bank of Jordan[13]. Mercantini *et al.* reported that most widespread fungal species were members of the genus *Chrysosporium* isolated from the Antarctic[14]. Al-Musallam investigated some Keratinophilic fungi from the folds in animal bodies[15].

Soon (1991) examined urban and rural garden soil samples from Malaysia for the isolation of Keratinophilic fungi, for this study 230 soil samples were collected and 98 isolates were obtained[16]. Youseef *et al.* conducted a preliminary study of Keratinophilic fungi from various sites of Ciaro in 1992[17]. Cano and Gurrao (1990) described a new genus of the Eurotiales of Keratinophilic fungi from Cuba. They collected 120 soil samples and a total of 22 species belonging 6 genera were recovered[18]. Simpanya and Baxter (1996)[19] carried out a study to examine the prevalence of Keratinophilic fungi in different sites of Palmerton North. They collected out of 236 soil samples 168 were positive for occurrence of Keratinophilic fungi. Papini *et al.* (1998) reported a survey of dermatophytes and related Keratinophilic fungi isolated from soil in a city park in Pisa, Italy[20].

Soomro *et al*. (2007) collected 125 soil samples from five areas of Khairpur city, Sindh, Pakistan for the screening of Keratinophilic fungi. Eleven species of eight genera were recovered[21].

Gugnani *et al*. (2012) examined one hundred eight soil samples from St. Kitts and fifty-five samples from Nevis. Forty-nine samples from St. Kitts and thirty-eight samples from Nevis were positive for the occurrence of Keratinophilic fungi and related dermatophytes[22]. Pakshir *et al*. isolated many Keratinophilic and Dermatophytic fungi from soil of different parks in Shiraj, Iran which were important for children and public health in 2013[23]. Bohacz and Korniłłowicz-Kowalska (2019)[24] recorded diversity and activity of Keratinophilic fungi using different quantitative and qualitative composition of lignocellulosic waste and chicken feathers from two composts.

Thomas *et al.* (2021)[25] 60 soil samples were collected from 60 dumping sites across Egba, Remo, Ijebu and Yewa regions of Ogun state. The percentage of dominant species *Aspergillus fumigatus* was found while the least dominant species were *Aspergillus carbonarius, Aspergillus*

versicolor and *Trichoderma longibrachiatum.* Manoyan *et al.* (2022) collected 50 soil samples from Moscow, Russia. Out of 50 samples 27 were positive, 21 of *Microsporum gypsium* and 6 of *Microsporum canis* were isolated[26].

Admirable work on Keratinophilic fungi has been done in India also. Garg (1974) reported an extensive study of Keratinophilic fungi from Indian soils[27]. Sharma (1983) has done taxonomical and physiological study of Keratinophilic fungi from Jaipur[28]. Singh and Agrawal (1983) isolated 143strains of Keratinolytic fungi from central India[29]. Sharma and Williamson (1984) isolated *Cephaliophora irregularis* for the first time from fungal flora in Jaipur soil[30]. Shukla and Rajak (1984) have done a comprehensive survey of Keratinophilic fungi in Jabalpur[31]. Sundaram (1987) recorded Keratinophilic fungi from rice field soil[32].

Rai and Qureshi (1994) studied the diversity of Keratinophilic soil samples of Chindwara, India. For the isolation of the Keratinophilic fungi from 20 different baits. They recovered 9 species belonging 3 genera[33]. Ramesh and Hilda examined 30 soil samples from primary schools and 15 soil samples from public parks in the city of Madras in 1998, they recovered and identified 31 species belonging 15 genera[34]. Deshmukh (1999) examined 87 soil samples from various areas of Mumbai. They recovered and identified 55 soil samples positive for occurrence of keratinophic fungi[35]. Deshmukh and Agrawal (2000) collected 88 soil samples from various site of Mysore, India to study the occurrence of Keratinophilic fungi. Out of 55 isolates they reported 12 keratinophilic fungal species belonging 4 genera[36].

Bhadauria and Sharma (2001) studied the distribution of Keratinophilic fungi in soil according to the pH of habitats and recovered 10 genera and 13 species of keratinophytes from 62 soil samples by using different baits like human hair, nails and feathers[37,38]. Deshmukh and Agrawal (2003) collected 112 soil samples from various areas of Jammu, India and screened them for the prevalence of Keratinophilic fungi and related dermatophytes. From 65 positive samples (58.1%), a total of six genera with 13 species were isolated[39]. Sexana *et al* (2004) investigated Keratinophilic fungal flora of Agra (U.P.)[40]. Anbu *et al.* (2004) studied the soil of 10 poultry farms from Namakkal and 12 feather dumping sites from Chennai and isolated 34 species belonging to 19 genera and one non sporulating fungus[41]. Vidyasagar *et al.* (2005) isolated Keratinophilic fungi from corridor dust of 11 hospitals and soils of 21 public palaces using a hair bait technique. A total of 41 species belonging to 24 genera were recovered[42]. Deshmukh and Verekar (2006) collected 122 soil samples from hilly areas of Himachal Pradesh, India, for a preliminary study of Keratinophilic fungi. One hundred one soil samples were positive for the presences of Keratinophilic fungi and related dermatophytes[43]. Singh *et al*. (2009)[44] examined indoor dust samples from 46 hospitals and 47 houses in Kanpur, India, for isolation of the dermatophytes and related Keratinophilic fungi. For this study, 230 and 235 samples were collected from hospitals and houses, respectively. Nineteen fungi represented by eleven genera were isolated. Sharma and Sharma (2010) studied the diversity of Keratinophilic fungi in school and college playgrounds soil, Jaipur. For this study, fifty soil samples were collected and twenty-five species belonging to genera were recovered[45].

Jain and Sharma (2012) reported 192 isolates belonging to 14 genera and 21 species of Keratinophilic fungi from various sites of campus of University of Rajasthan[46]. Deshmukh and Verekar (2014) collected 150 soil samples from 11 district of Vidarbha

region of Maharashtra, India. They recovered and identified 71 isolates which were belonging thirteen species of eight genera[47]. Sharma and Choudhary recorded that the soil of agricultural fields in the Saharanpur Village (U.P) is rich source of pathogenic keratinophilic fungi including some species of dermatophytes in 2015[48]. Sharma and Mahariya (2017) conducted a preliminary study of Keratinophilic fungi from soils. They collected soil samples from twenty public park of Jaipur district; India and a total of fifteen species of five genera were recovered[49]. Pahare *et al.* (2018) reported 18 different fungal species from soil of cattle house located in Bilaspur, Chhattisgarh, India[50]. Another study was carried out by Jangid and Begum in 2018, they collected 36 soil samples from the twelve-garbage dumping area of Ajmer district to examine the frequency of occurrence of Keratinophilic fungi and related dermatophytes[51]. Khan and Bhadauria (2019)[52] reported Keratinophilic fungi from various places of Jaipur Rajasthan. Kumawat *et al.* (2020) concluded that the soil of Rajasthan, India may be major reservoirs for the growth and existence of keratinophilic fungi because of its very hot, humid and semi-arid environment and soil pH. Neutral to alkaline soils provided favourable conditions for the growth of keratinophilic fungi whereas acidic soils were found to be unfavourable[53]. Kumawat *et al.* (2020) carried out a study to examine the prevalence of Keratinophilic fungi in semi-arid zone of Rajasthan. For this investigation, fifty soil samples were collected from Jaipur, Sikar, Alwar and Ajmer in India. A total of thirty-one fungal species of sixteen genera were identified[54].

Agarwal *et al*. (2021) reported that the humus of "Phumdis" in fresh wate Loktak Lake is reservoir of keratinophilic fungi which can pose serious health risk to its users, particularly the tourists and the employees. [55] Jain and Sharma (2022) concluded that the unsterilized soil and SDA medium were more suitable for survival of all keratinophilic fungi.[56]

Jain and Maida (2022) collected 32 soil samples from Mahakal temple in Ujjain (M.P.), India and observed that 27 samples (84.3%) were positive. [57] Jambolkar and Yadav (2023) conducted a preliminary study of keratinophilic fungi from Kerman Province (district Barwani). They collected 100 soil samples and a total of five genera were observed. [58]

Conclusion

It is evident from the above account that soil is the main habitat for fungi worldwide and as such, the main reservoir for keratinophilic fungi and their activity. Keratin a natural proteinaceous complex substrate, degraded by the keratinolytic activity of these fungi. Besides, it will be expected that new species of keratinophilic fungi could be identified.

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