Relevance of keratinophilic fungi

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With the invention of the technique of isolation of soil fungi, studies on keratinophilic fungi (Figure 1 *a*) started in 1952 and soil proved to be natural reservoir of these fungi. Keratinophilic fungi also include dermatophytes, which cause diseases of the skin and its appendages. Keratinophilic fungi have the unique ability to degrade keratinous substrates, e.g. hair (Figure 1 *b* and *c*), horns and hooves (Figure 1 *d* and *e*), feathers (Figure 1 *g–k*), and nails (Figure 1 *i*). The fungi which degrade these substrates completely are termed as keratinolytic. Several keratinolytic dermatophytes survive in the soil, in addition to their clinical habitat. Currently, almost all the habitats of the world have been surveyed for the presence of keratinophilic fungi[1]. Most of these fungi belong to families Arthrodermataceae and Onygenaceae, order Onygenales in Ascomycetes[2]. Most of the known fungi grow on higher plants or their remains, and survive saprophytically. The Arthrodermataceae and Onygenaceae are unusual in that majority of them are associated with birds and mammals. These are true fungi that vigorously degrade keratin and include important human and animal pathogens. The most commonly occurring fungi are *Chrysosporium*, *Geomyces*, *Malbranhea*, *Microsporum*, *Oideondron*, *Sporendonema*, *Trichophyton* and their 17 teleomorphs.

Degradation of hair, nails, feathers, horns and hooves in the soil is carried out efficiently and these substances are recycled by these fungi. Human hair penetration (Figure 1 *f*) by mechanical and enzymatic action is a specific feature of keratinophilic fungi. The keratin-degrading fungi produce the enzyme keratinase, which has attracted a great deal of attention in recent times. The keratinases are involved in enormous industrial and medicinal applications. Hence, these keratinophilic fungi and their

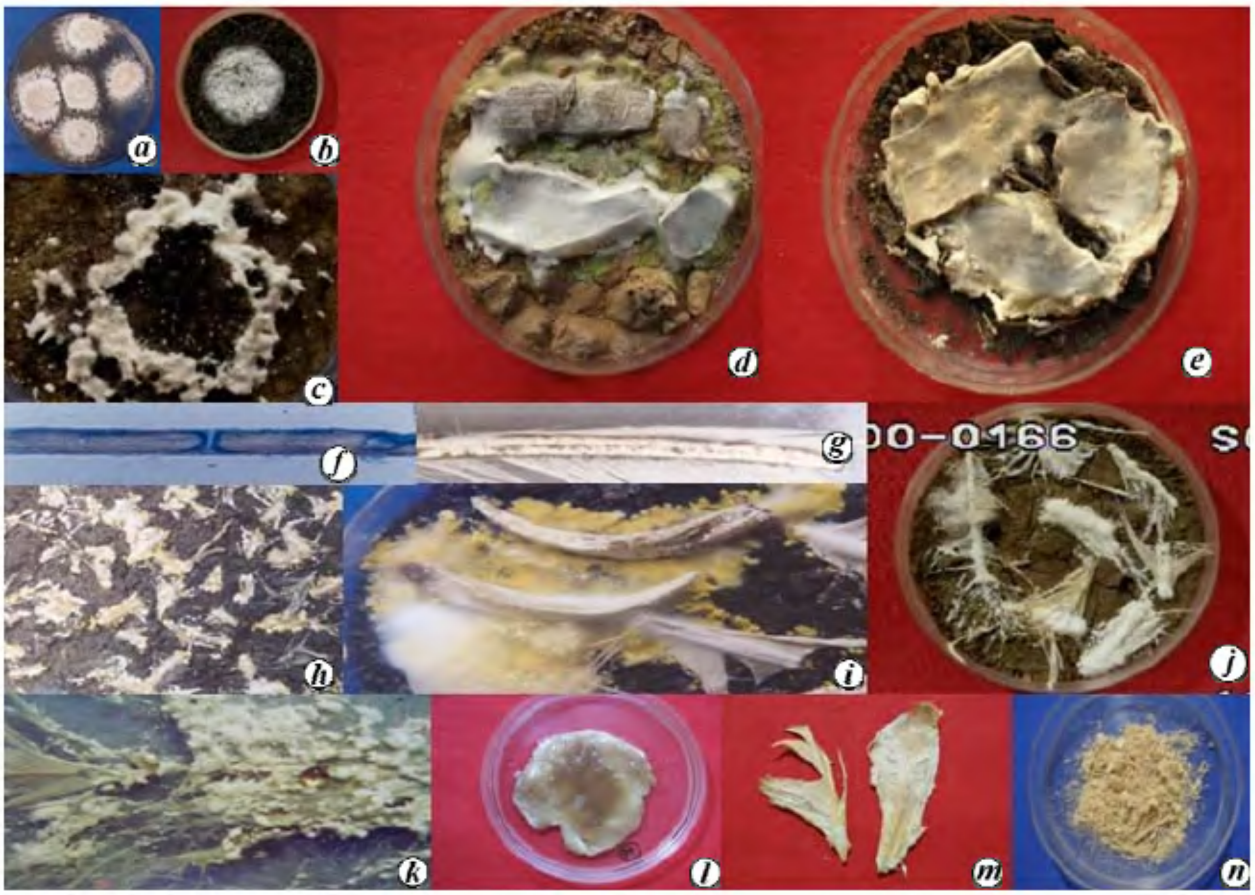

Figure 1. Keratinophilic fungi and their action. ***a***, Keratinophilic fungal colony; ***b***, ***c***, Keratinophilic fungi on human hair; ***d***, ***e***, Animal horns and hooves decomposition in soil; ***f***, Human hair breakdown; ***g***, Hen feathers showing growth of these fungi; ***h***, ***j***, Feather decomposition in soil; ***i***, Bird nails overgrown by these fungi; ***k–m***, Different stages of feather decomposition *in vitro*; ***n***, Feather powder as a result of enzymatic decomposition by *Gymnoascus intermedius.*

extracellular metabolites are of practical relevance. Some of their applications are as follows.

Several millions of tonnes of feather waste generated by poultry and other livestock leads to troublesome environmental pollution. Wastage of protein-rich reserve is ultimately converted into feather meal using keratinolytic fungi[3,4]. The addition of microbial digested feather meal to the animal feed improves digestibility and bolstered growth of poultry. Nutritional enhancement can also be achieved by hydrolysis of raw feathers using these keratinolytic fungi (Figure 1 *l*–*n*). Microbial-digested feather meal is also used as slow nitrogen-releasing fertilizer. Keratinophilic fungi are used for the production of biodegradable films, coatings and glue from keratinous waste.

Keratinases of these fungi are utilized in enzyme-based detergents which are used in the removal of keratinous soils, common in the laundry, on collars of shirts, etc. These enzymes are also used for cleaning up of drains clogged with keratin waste. These keratinases are also employed in the leather industry in hair-saving dehairing in place of chemical-based dehairing. Recently, these keratinases have been found to degrade prion protein leading to the prevention/cure of mad cow disease[5,6]. Further, keratinases are applied in the modification of silk and wool fibres, for acne or psoriasis, for making vaccines of dermatophytosis and has addictives in skin-lightening agents. In addition to the keratinases, these fungi have the potential to generate natural gas for fuel from poultry-waste degradation.

In spite of their high industrial and medicinal potential and abundance in the soil, most of these fungi are neither deposited in Indian Culture Collections nor available with the scientists working on them. Therefore, there is an urgent need to isolate and conserve these fungi for exploitation of their biotechnological potential.

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