

MECHANISM OF DERMATOPHYTIC INVASION

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Summary

A discussion on the mode of invasion by the dermatophytes. Experimental studies lend support to enzymatic keratin break down. Certain intriguing questions on the behaviour of dermatophytes are briefly highlighted.

KEY WORDS: Dermatophytes Keratinolysis.

Several million years ago the Age of Reptiles resulted in the shedding of large quantities of skin scales, horn and feather material. This abundant matter was exploited by the fungi, which after adopting certain characteristics, came to be termed 'keratinophilic'. The dermatophytes evolved from this group and today, they are responsible for the majority of cases seen in the skin clinics, particularly in our country. The object of this article is to critically look into the mechanism of action.

The keratinophilic nature of these fungi induced people to cultivate them on feather, wool, human and animal hair. Nevertheless, it has also been experimentally shown to invade the dermis¹, proving thereby that they are not strictly keratinophilic. In the

living, deeper invasion of the epidermis is prevented by a humoral factor present in the serum². Despite their acceptance as pathogens, the dermatophytes have failed to fulfill Koch's postulates³.

The growth of dermatophytes on keratinous substrates, loss of weight in natural keratin incorporated in actively growing cultures^{4,5} and the appearance of aminoacids based on the ability of the fungus to digest human hair keratin⁶, have all been put forward in support of enzymatic keratinolysis. In contrast, it has also been shown that these fungican effectively utilise simpler substrates i.e., nonkeratin⁷, obviating the necessity for keratin-dependent parasitism. Based on studies with nail keratin, Raubitschek and Maoz⁸ supported the mechanical rather than the chemical mode of invasion. This nonkeratinous substance utilised by the fungus was referred to as the nonfibrillary matrix⁹.

The electronmicroscopic studies on hair infected by *Trichophyton mentagrophytes*¹⁰ and the presence of tunnels around hyphae in mycotic nails¹¹ favour an enzymatic rather than a simple mechanical process. Specialised structures, endowed with keratin digesting

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properties have been described¹² and it is possible that certain enzymes may be secreted at the tips of these processes, facilitating keratin breakdown. The isolation of proteolytic enzymes^{13,14} and the observations of dermatophytic growth on ethylene oxide sterilised wool^{15,16} and wool made radioactive by the incorporation of cysteine¹⁷ support the concept of enzymatic keratinolysis. Further, these studies suggest that keratinolysis is not the initial but the end result of a series of chemical events. Using egg albumin, the proteolytic activity of dermatophytes has been studied and varying levels of enzymes in the different species have been shown¹⁸. The first isolation of an extracellular keratinase was by Yu et al¹⁹ from *Trichophyton mentagrophytes*. The aminoacid composition was worked out and it was called keratinase I²⁰. The same workers²¹ isolated and purified two cell bound keratinases from *T. mentagrophytes* and named it keratinase II and III respectively.

In conclusion, it emerges that evidences in favour of an enzymatic process are overwhelming and this is the first requirement for keratin-dependent parasitism²². However, these observations raise certain interesting questions e.g., why is the scalp exempt from infection by *Epidermophyton floccosum*? What enables *Trichophyton rubrum* to more effectively invade the hard keratinous structures than other species? What are the other factors that modify and determine the virulence of a particular species? Though Weary and Canby¹⁶ have pointed out that keratinolytic activity based on the observations limited to a particular species of dermatophyte may not be valid for the others, some authors contend that conflicting data in the literature on keratinolysis by dermatophytes may be explained by the disparity in the nature of material

studied (dermatophyte species, origin of hair) and or the use of an unsuitable technique²³. It would be worthwhile in future to develop a standardised biochemical technique which could serve to clarify the observations arising from different studies.

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