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Keratinophilic Fungi: The Destroyer of the Wool Fibres

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Abstract: Wool is one of the important textile commodity obtained from the bodies of sheep all over the world. The wool fibers are soft, warm and flexible and made of Keratin and therefore easily colonized degraded and destroyed. Research has shown that wool is not only destroyed by Keratinophilic fungi, but two other fungal species such as *Penicillium* sp. and *Aspergillus* sp. also contribute its degradation. In this regard, I have started experimenting to comprehend the actual agent involved into destruction of the wool fibers. The results will be published through present journal as Research advances.

Key words: Keratinophilic fungi, keratin, wool, sheep, anatomy, dermis, sebaceous, sudiferous, cuticle, cortex, paracortex, orthocortex, medulla, medullation, disulfide, proteolytic, enzymes, keratinases, keratinolysis, propagule, carbon, antifungal, fumigation, disinfectant

Introduction

Wool has been used for thousands of years. Ancient remains suggest that wool was used in the late stone age, when the first sheep were domesticated. The ancient *Babylonians* made wool clothes more than 5000 years ago. Woolen textile were known by the ancient Egyptians, Hebrews, Greeks and Romans. Wool also became trade commodity and helped to build strengthen the economy of many countries. *Argentina*, *Uruguay*, *South Africa*, the *US* and *Russia* and *Contries of Asia* are the main wool producing regions now a days. (Potter, 1971; James, 1983).

In certain domestic and climatic conditions wool provides warmth and physical comfort better than cotton and linen fabrics. These qualities combined with its soft resiliency make wool workable for manufacturing, the rugs, carpets and blankets. (Potter, 1971; James, 1983).

How is wool obtained: Wool is obtained from more than 200 breeds and cross breeds of sheep world wide. Sheep are generally shorn of their fleeces in spring season, however the time of shearing varies in different parts of the world depending on the climate and marketing schedules of the herder. In retrospect, sheep were shorn by hands but now by electric clippers which shear more closely and faster than hands. In the regions, where large ranches are far from one another shearing crews travel from ranch to ranch to clip the sheep. Owners of small bands of sheep may shear the sheep themselves or hire a local shearer. Besides, the wool is also obtained from angora, the Kashmir goat, camel, alpacas, llamas and vicunas. However Merino sheep produce the finest wool.

The raw stock of wool must be carefully processed for grades and separated according to the length, color, luster and quality of fibers for commercial use. The quality and grades are decided by climate, food that animals utilize, and by the age and health of sheep.

Anatomy of the wool: Like hair, wool grows out of skin, varies into length as 4-35 cm. It has a complex organized structure growing from a Follicle supplied with Sebaceous and Sudiferous glands and buried in dermis of skin (Fig. 1). The sebaceous gland secretes wool grease and the sudiferous gland produces sweat or suint. Both glands open into the follicle. Their secretions function as lubricants and protectants for the wool fiber as it grows.

A cross section of the shaft reveals three layers: The Cuticle, the cortex and the Medulla (Fig. 2).

The main distinctive characteristics of cuticle are:

- (a) Looks like scales.
- (b) Overlapping serrated Cells.
- (c) Free ends of scale point towards the tip (Fig. 3).

For manufacturing purposes wool fibres are twisted or pressed together tightly, the scales lock into one another. During this process the wet wool fibres are easy to work. Consequently, this property makes wool a most desirable fibers for felting. Nonetheless, it is observed that the wool materials are easily matted when they are washed and squeezed.

The cortical layer lies beneath the cuticle. Its long spindle cells contribute tensile strength and elasticity to the wool fibers. Cortex is further divided bilaterally into a Paracortex and an Orthocortex. This is demonstrated by the use of a preferential dye (acid or basic) which is taken by the orthocortex and is visible in a cross section view.

In medium and coarse wool, the medulla, comprises super-imposed honey comb like cells filled with air. Medullation is a problem to the manufacturer inasmuch as fibers possessing it have lower spinning properties and are lustrous, straight and coarse.

Chemical composition of the wool: Wool is primarily composed of a protein known as Keratin. Keratin is highly insoluble protein having fibrous helical structure with numerous disulfide linkages among the amino acids, which give resistance to keratin against proteases and acids. But it is hydrolyzed by alkalies and specific enzymes known as Keratinases produced by Keratinophilic Fungi (Grant and Long, 1981; Takiuchi *et al.*, 1984; Grzywnowicz *et al.*, 1989).

Effects of Keratinophilic Fungi on the wool: Keratinophilic fungi are certain loving organisms. They grow on keratin containing materials such as skin, nail, hair, fur feather, horn, wool etc. For Keratinophilic fungi the keratin material is carbon source and fundamental for growth and reproduction activities. Keratinophilic fungi are abundant in situations where keratin substrates are common (Cooke, 1980). Mandels *et al.* (1948) has reported the keratinophilic fungi from the soil and discovered that these keratinophilic fungi can grow on the wool. Similarly the experimental research carried out by Grant and Long (1981) showed that keratinophilic fungi attack

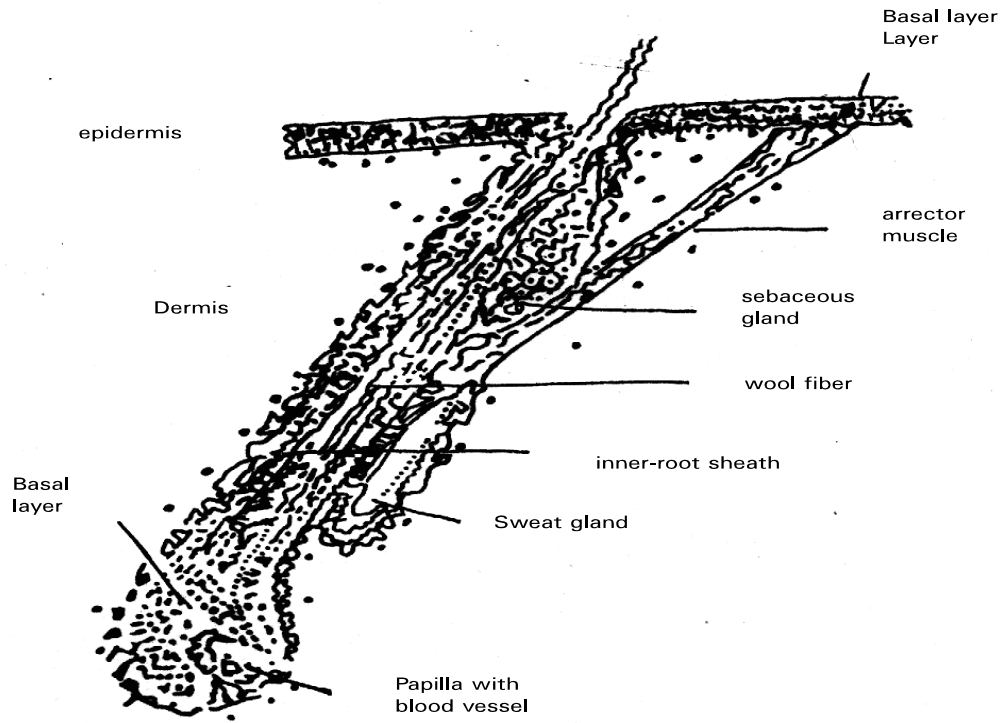


Fig. 1: Longitudinal section of a completely developed nonmedullated wool follicle magnified about x 100. Including sebaceous and sweat glands (After wildmaH)

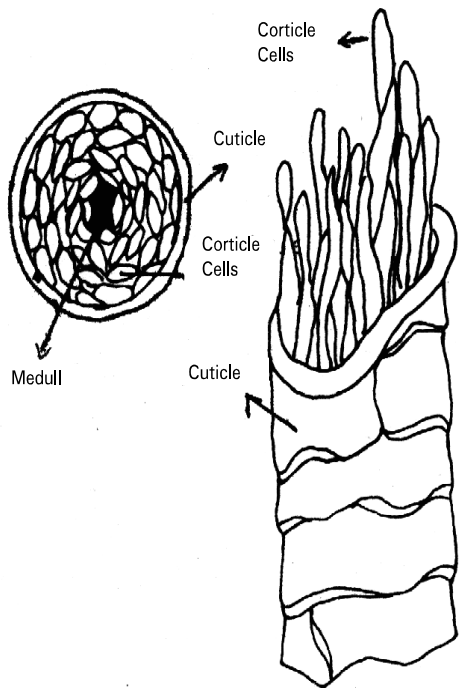


Fig. 2: Cuticle, cortex and medulla of wool fiber

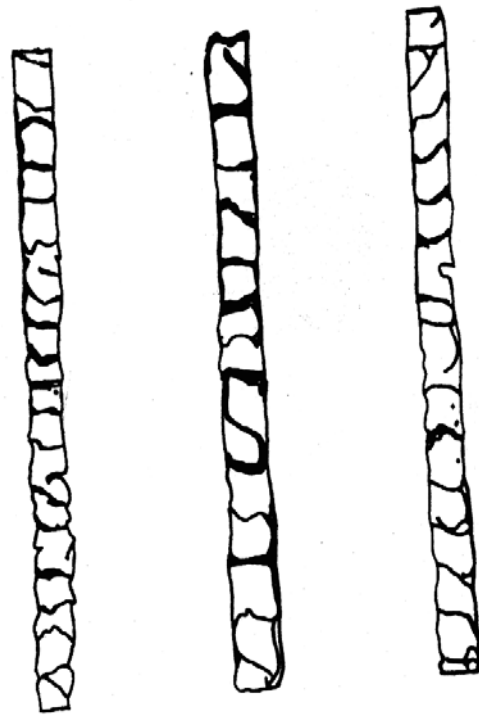


Fig. 3: Scale formation of Delaine Merino wool fibers

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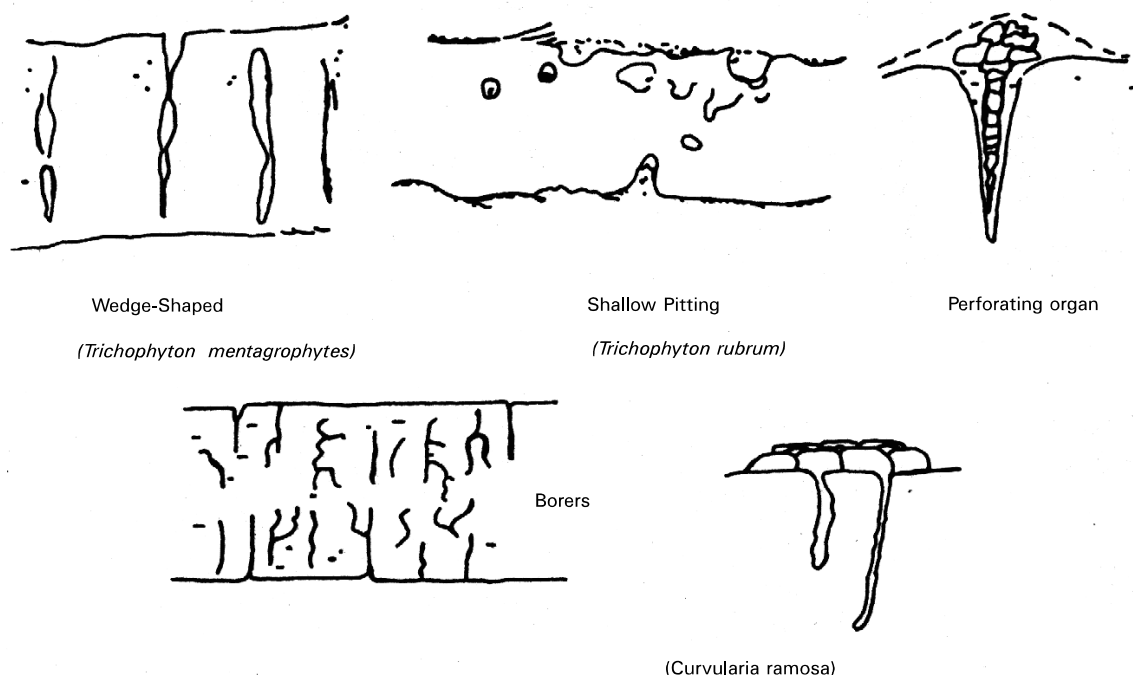


Fig. 4: Possibly different types of perforation caused by different keratinophilic fungi on wool

on the keratin present including wool.

When propagule of keratinophilic fungi comes into contact with wool it digests it in a characteristic way. When attacking a wool fiber keratinophilic fungi produce and secrete keratinases and penetrate under the cuticle and between the cortex cells by means of flattened frond like mycelium. Also wide celled perforating organs and borers grow in to the cortex following deep pits (Roberts and Meckanzie, 1985). Around both frond and perforating organs are wide zones of keratinolysis. This combined mechanical and lytic attack can destroy the wool in few weeks (Fig. 4).

Research has shown that keratinophilic fungi are combination of several species such as *Keratinomyces* sp., *Trichophyton* sp., *Microsporium* sp., *Epidermophyton* sp., *Ctenomyces* sp., *Chrysosporium* sp., *Arthroderma* sp., *Anixiopsis* sp., *Pseudogymnoascus* sp., *Auxothron* sp., *Sepedonium* sp., *Keratinophyton* sp., *Geomyces* sp., *Malbranchia* sp., *Ochroconis* sp., *Botryotrichum* sp., *Scopulariopsis* sp., *Roladina* sp., *Botrytis* sp., *Amauroascus* sp., *Gymnoascus* sp., *Arachnotheca* sp., *Myceliophthora* sp., *Aleurisma* sp., *Bysoonygena* sp., *Curvularia* sp. etc. (Soomro, 1994; Soomro and Zardazri, 1996). Besides keratinophilic fungi the other fungal species such as *Penicillium* sp. and *Aspergillus* sp. also carry capability to degrade and destroy the wool (Jain and Agrawal, 1980). For more precise understanding of the issue at hand, it is still not clear that, as mentioned above, whether individual species is degrading the wool or more than one are attacking party of the wool.

Due to the destruction caused through the attack of keratinophilic fungi and other species the wool loses its

commercial value. Therefore, antifungal spray or fumigation with disinfectants is advised to the traders and textile manufacturers to protect their wool production for better quality and commercial value.

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