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Enzymatic treatment of wool fabrics - opportunity of the improvement on some physical and chemical properties of the fabrics

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ABSTRACT
The enzymatic treatment of textiles significantly improves some of their physicochemical properties as well as increases their aesthetic values and comfort of use. Enzymes are used in order to develop environmentally friendly processes by reducing the concentration of chemical agents, water and energy consumption. In the present study, an attempt was made to treat the wool fabric with different concentrations (1, 3, and 5 g/L) of protease enzyme and observed the effects on physical and chemical properties including softness, absorbency, pilling resistance, weight loss, tensile strength loss, water retention, felting shrinkage, alkali solubility and urea-bisulphite solubility of wool fabric. The results of pretreated and enzyme-treated samples are compared to those obtained for untreated wool fabric. Enzyme-treated wool fabrics showed improvement in softness, absorbency, pilling resistance and felting shrinkage and a slight increase in weight loss, tensile strength loss, alkali solubility and urea-bisulphite solubility, and decrease in water retention of the fabric.

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Wool fabric; protease enzyme; pretreatment; enzyme treatment; physical and chemical properties

Introduction

Wool is a product of nature; it is formed in the proper skin of sheep. Wool is a complex natural fibre composed mainly of proteins (97%) and lipids (1%), with a heterogeneous morphological structure (Heine & Höcker, 1995). It is built from a protein called keratin which is formed in the process of biosynthesis of α-amino acids. Wool fibre is in fact a creation of dead cells. The wool-forming cells show diverse structures, shapes and properties. Cells of the same kind group together to form characteristic parts of hair. The major parts of the wool fibre structure are the cuticle, the cortex and the core. The external layer of the fibre (the cuticle) is a bundle of cells which have a structure of scales (Cortez, Bonner, & Griffin, 2004). The wool surface morphology requires a special wool textile finishing process. The cuticle cells (or scales) of wool fibres overlap with each other forming the surface of the wool. They are largely responsible for important properties of wool such as wettability, felting behaviour, dyeability and printability (Sousa et al., 2007). The cortex comprises spindle-shaped cortex cells that are separated from each other by a cell membrane complex. The cortex, comprising 70–90% of the fibre, determines its physical and chemical properties and is not very resistant to chemical factors. It is also a carrier of pigments, giving the fibre its specific colour. Wool cuticle cells are subdivided into two main layers, namely the exocuticle and endocuticle (Plowman, 2003). The outer surface of the scale of the cuticle is covered by a very thin membrane called the epicuticle. Below this hydrophobic epicuticle, there is the exocuticle, a cystine-rich component forming about two-thirds of the scale structure. Below the exocuticle, forming the remainder of the scale structure is the endocuticle and then a thin layer of intercellular cement (Feughelman, 1997). The exocuticle shows lower chemical, enzymatic and mechanical fastness, whereas the endocuticle has significant fastness to chemicals and enzymes. The core of the fibre is characterised by a cellular structure.

Chemical modification of hydrophobic surface structure of wool fibre leads to the improvement of the functional quality of these fibres. The use of chlorine as a fibre-modifying agent produces toxic adsorbable organohalogens (AOX) by-products in the effluent. Growing environmental legislative pressures and rising wastewater costs have brought the enzymatic treatment of textile materials as a possible alternative to chlorine treatments. There is a possibility of substituting conventional chlorine treatment by the enzymatic process, which leads to a reduction in water, chemical and energy consumption (Silva, Prabaharan, Gübitz, & Cavaco-Paulo, 2005).

In recent years, there has been increasing interest in enzymatic treatments for textile fibres, and a variety of new enzyme-based products and processes (utilising cellulases, amylases and lipases, as well as proteases) are already being marketed (Fornelli, 1993). It is suggested that the softening benefits that are achieved by protease treatments on wool fabrics may, under certain conditions, derive from reduced fibre-bending stiffness rather than from changes in inter-fibre friction (Nolte, Bishop, & Höcker, 1996).

There is increasing interest in the use of enzymes in wool-processing. One of the main reasons for this wider attention of

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