Development of a Sustainable Single-Bath Enzymatic Pretreatment Process for Hemp-Based Blended Fabrics

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Abstract

The increasing demand for sustainable textile production has accelerated the use of environmentally friendly fibers such as hemp. Despite its ecological advantages, hemp fiber processing still largely relies on conventional chemical-intensive pretreatment methods, which generate significant environmental burdens. In this study, a sustainable and efficient alternative approach based on single-bath enzymatic pretreatment of hemp-based blended fabrics was investigated.

Within the scope of the study, hemp/cotton/polyamide/elastane blended woven fabrics were produced and subjected to enzymatic pretreatment processes using pectinase, cellulase and laccase enzymes. Laboratory-scale experiments were conducted by varying enzyme concentration, treatment time and mechanical effect. The effects of these parameters on fabric performance were evaluated in terms of hydrophilicity, whiteness, colorimetric properties and surface morphology.

The results demonstrated that enzymatic treatments significantly improved fabric hydrophilicity and surface cleanliness while maintaining acceptable mechanical integrity. Among the tested enzymes, cellulase and pectinase showed promising performance in enhancing wettability, whereas laccase influenced color properties due to its oxidative mechanism. Additionally, preliminary findings indicated that enzyme combinations may provide synergistic effects, offering potential for further process optimization.

This study proposes an innovative, resource-efficient and environmentally friendly alternative to conventional multi-bath textile pretreatment processes. The developed approach is expected to reduce water, energy and chemical consumption while enhancing the value of hemp-based textile products.

Keywords: Hemp fibers, enzymatic pretreatment, single bath process, sustainable textiles, hydrophilicity, ecofriendly processing

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