

## ABSTRACT

Organic cotton is grown without using fertilizers in the cultivation plant as compared to conventional cotton planting. Organic cotton used in textile and apparel industry for development of biodiversified products in medical textiles such as wound dressing, surgical gowns and baby care skin clothing are grown in the past years. The processing of organic cotton in textile wet processing is recommended by the Global Organic Textile standard (GOTs) which framed the guidelines for textile processing through mild chemicals and/or go with enzyme technology. In the present industrial practices, the pectinase enzymes are used for bioscouring of cotton materials, but drawback of the pectinase enzyme is it removes or break downs only pectin groups in the cotton fibre structure, which is not sufficient for removal of wax, oil and fatty substances in the fibre. However, recent biotechnology and genetic engineering advances have opened opportunities for successful applications of other enzyme systems, such as lipases, xylanases, laccases, proteases and alkaline pectinases.

The aim of this research work is to study the performance of biopreparation of organic cotton fabrics in biodesizing and bioscouring processes through specific mixed enzymatic system. In order to analyse the physical characteristics of biotreated organic cotton fabrics and to identify the important process parameters in single stage enzymatic desizing, scouring and bleaching for organic cotton textiles, the main objectives of the proposed work include, (1) to synthesize and characterize alpha amylase, alkaline pectinase, protease, lipase and cellulase enzymes from standard bacterial culture for enzymatic desizing and scouring of organic cotton fabrics, (2) to optimize the important process parameters such as enzyme concentration,

temperature, pH and reaction time in enzymatic desizing of organic cotton fabric using alpha amylase, (3) to optimize and characterize the pectinolytic and proteinolytic activity of alkaline pectinase, protease, lipase and cellulase enzymes on the organic cotton fabric, to identify the optimum process parameters in bioscouring treatments using artificial neural networks, (4) to identify key parameters that influences the improved enzyme reaction on the bioscouring process through ultrasonic system (sonication) and aerodynamic system (air pressure), and (5) to develop and identify the important process parameters of single stage enzymatic desizing, scouring and bleaching for biopreparation of organic cotton textiles.

First, the aim of this research work is to study, the potential of enzyme technology to design an efficient and low-temperature scouring process for 100% organic cotton fabric using alkaline pectinase at various concentrations, temperatures, pH and time. The enzyme treated organic fabrics were analyzed for the percentage of fabric weight loss, pectin removal, wax removal, water absorbency, whiteness index, yellowness index and brightness index; and their results were optimized using Design Expert 8.0 software to achieve required level of bioscouring process. In the pectinase scouring, major limitations in the use of pectinase are posed by incomplete removal of wax, oil and low volatile substances.

Second, efforts are made to improve the efficiency of bioscouring process with novel attempts by combination of binary and territory enzymes in the bioscouring of organic cotton fabrics to enhance the enzyme reactions to remove wax and oil substances. Processing of organic cotton fabrics using enzymes, for replacing strong conventional chemicals, with an aim to provide a comprehensive preparatory process combined with bacterial enzymes, as a

value proposition has been attempted in this research work. Process parameters of individual enzyme treatments, binary enzymes and mixed enzyme treatments have been optimized with Artificial Neural Networks (ANN) and Box-Behnken Method for optimum treatment time, temperature, pH and concentration of enzymes.

Third, the present study was focused on improvement of the enzymatic bioscouring performance by using specific mixed enzymes such as alkaline pectinase, protease, lipase and cellulase enzymes.

Fourth, an attempt has been made to study the pectinolytic and proteolytic activity of degrading rate of pectin and removal of wax on the organic cotton fabric at various enzymatic process conditions such as enzyme concentration, temperature and time by normal method, ultrasonic method (sonication) and aerodynamic method (air pressure). These process variables are selected based on the artificial neural network (ANN) using MATLAB 7.0 software and output of experiment resulted with fabric physical properties such as fabric weight loss, water absorbency, wetting area, whiteness index, yellowness index, and brightness index. The enzymatic scoured organic cotton fabric was tested for wax content and pectin degradation rate on the fabric and their results were optimized with minimum error.

The test results were analyzed to predict the optimum process parameters to achieve the required bioscouring organic cotton fabric properties and removal of pectin degrading rate and their results were compared with actual trials. The sonication and aerodynamic method of boosting the enzyme reaction for their kinetics will be helpful to the organic cotton processors for the eco-friendly and sustainable textile wet processing using specific mixed

enzymatic system in bioscouring processes to do shorter time and mild conditions.

The bioscouring performance of 100% organic cotton fabric using mixed enzymatic system was also studied through ultrasonic (sonication) and aerodynamic (air pressure) treatments at various process variables using artificial neural network. From the research study, the interesting conclusions were derived. The output result of the software to achieve the desired bioscouring of organic cotton fabric in the specific mixed enzymatic system opted best process conditions at 8% alkaline pectinase, 3% protease, 0.8% lipase and 0.8% cellulase process condition at temperature of 55 deg C and reaction time 60 minutes at pH 8.5 with 1.0% desirability. The actual pectin and weight loss of the bioscoured organic cotton fabric was achieved 68.40% and 4.80% respectively with error of 1.218% in case of with ultrasonic treatment. The sonicator efficiency was achieved 8-12% higher bioscouring performance on organic cotton fabric through mixed enzymatic system when compared to without sonication. In case of aerodynamic method, the actual pectin and weight loss of the bioscoured organic cotton fabric was achieved up to 78.40% and 4.92% respectively with error of 1.018. The overall aerodynamic efficiency was achieved 9.72%, 24.08% and 37.20% treated at 8 kPa, 12 kPa and 16 kPa air pressure levels respectively on organic cotton fabric through mixed enzymatic system when compared to without aerodynamic.

This study will provide the industrial bio-scouring technologies an insight into the properties of mixed enzymatic systems and the predictability of their scouring performance while deciding the recipe and process parameters.