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Sveučilište u Zagrebu Tekstilno-tehnološki fakultet
Prilaz baruna Filipovića 28a, 10 000 Zagreb

Glavna urednica
doc. dr. sc. Sandra Flinčec Grgac, zamjenica voditeljice doktorskog studija

Urednički odbor
prof. dr. sc. Stana Kovačević
doc. dr. sc. Sandra Flinčec Grgac
prof. dr. sc. Tanja Pušić

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ANTIMICROBIAL EFFECTIVENESS OF TEXTILE MATERIALS

Jelena PERAN
University of Zagreb Faculty of Textile Technology, Prilaz baruna Filipovića 28a, 10 000 Zagreb
jperan@ttf.hr

1. Introduction

Natural and natural-based textile materials are particularly vulnerable to the attack of microorganisms due to their large surface area, moisture content and chemical composition, especially in humid and warm conditions. Carbohydrates in cellulose can serve as a source of food and energy for various microorganisms, and can be broken down through a process of enzymatic hydrolysis. Wool, silk and other protein fibres can also be enzymatically degraded by proteolytic enzymes (protease) and/or keratinolytic enzymes. On the other hand, synthetic fibres are resistant to microbial attack, and the process of degradation, and are long lasting. The presence of microorganisms on textiles, in particular pathogenic types of bacteria, represent a health hazard. Their presence can be indicated by the appearance of different stains, odours and deterioration in terms of degree of polymerisation, strength and rigidity [1,2]. Antimicrobial treatments of textiles are carried out in order to prevent this hazard through control and elimination of growth and reproduction of microorganisms. There is a number of requirements for antimicrobial finishing [3,4]: (i) efficiency against broad spectrum of microorganisms, but at the same time low toxicity to consumers and the environment; (ii) antimicrobial agents must not affect the natural flora of non-pathogenic bacteria that exist on human skin and represent a natural protection; (iii) durability under different conditions (wear, laundering, dry cleaning and hot pressing); (iv) compatibility with different chemical agents and textile processes; (v) they should have no influence on the quality and appearance of textile, (vi) resistance to sterilization conditions (medical textiles) and (vii) ease of use and cost effectiveness.
The aim of the dissertation is to achieve durable antimicrobial effectiveness of textile materials using different antimicrobial agents and techniques.

2. Antimicrobial Agents

Antimicrobial agents differ by mechanism of antimicrobial activity and degree of efficiency. They can act by contact (passive agents) where they inhibit microbes only in the case of direct contact, or by diffusion (active agents) where they diffuse from textiles into the environment to get in contact with the microbes [4,5]. Biostats are antimicrobial agents that inhibit the growth and reproduction of microorganisms, whereas biocides completely kill certain types of microbes. Known antimicrobial agents regularly used in textile industry include quaternary ammonium compounds, polybiguanides, triclosan, N-halamines, chitosan, nanoparticles of noble metals and metal oxides [6]. Due to their potential toxicity, questionable ecological acceptability or durability issues, the usage of some of these antimicrobial agents is limited. In previous paper [7] researches dealt with antimicrobial efficacy of cellulose based fabrics treated with silver nitrate solutions. In recent years, the application of natural, plant based products, such as black cumin seed oil (*Nigella sativa L*) and neem leaf oil (*Azadirachta indica*) as antimicrobial agent is being investigated [8]. These natural compounds have exhibited potential antimicrobial activity without harmful effects to the surrounding medium.

3. Antimicrobial treatments

Taking into consideration that antimicrobial agents are consumed when in contact with microorganisms, the durability of antimicrobial performance under different conditions of use represents a challenge.

In order to achieve antimicrobial effectiveness and improve durability, depending on the antimicrobial agent that is intended to be used and fibre type, different approaches have been developed. These can generally be divided into two groups: (i) inclusion of antimicrobial agent into polymer and (ii) grafting onto textile by surface coating techniques [9]. Antimicrobial agents can be incorporated into the fibre in chemical fibre formation stage by introducing agent into polymeric granules prior to the preparation of polymeric melt, or directly into polymeric melt or solution prior to spinning. The activity may be reduced due to restricted diffusion of the agent molecules through the polymeric matrix and the method is only applicable for synthetic fibres. Apart from conventional wet methods of coating (padding, bath immersion), which use large quantity of water, chemicals electrical energy and produce large volume of waste, new, eco-friendly techniques are being researched. These are microencapsulation, sol-gel coating, enzymatic surface modification and plasma technology. They could overcome the drawbacks of wet chemical finishing.

4. Conclusion

The primary function of textiles, which is to provide comfort of the consumers by protecting them from different climate conditions, has expanded. Clothing must perform multiple functions, from aesthetic to special functions such as injury and fire protection, therapeutic and rehabilitative function, odour control and microorganism protection. Although, a number of antimicrobial agents and techniques are currently being used, new challenges arise. Increasing microbial resistance to conventional antimicrobial agents, toxicity for human health and the environment, along with durability issues, need to be resolved. More efforts must be invested to research and develop more environmentally friendly techniques and antibacterial agents.

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