



STUDY OF PHYSICOCHEMICAL PROPERTIES OF COTTON/POLYESTER BLEND FABRICS DYED WITH CHITOSAN APIS MELLIFERA

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Abstract: This study presents the possibility of improvement of dye exhaustion during dyeing of cotton and polyester mixed fabric with dispers and reactive dyes after treatment with chitosan. This experiment presents a new way to dye the cotton/polyester mixed fabric with dispers/reactive dye after treating with chitosan. The depth and fastness of shade of dyed fabric were analyzed by comparing the chitosan treated samples with untreated dyed fabric samples.

Key words: cotton, polyester, mixed fabric, chitosan, viscosity, dyeing, dispersed/active dyes.

Introduction

In the recent year, fabrics made from cotton-polyester fibers are widely used. This ensures that the inconveniences that occur in cotton fiber are eliminated due to the mechanical properties of synthetic fibers [1]. The main reason for this is the absence of active chemical groups in the macromolecules of polyester fibers. For this reason, disperse dyes are mainly used. The second fiber in the composite fabric is cellulose fiber with hydrophilic properties, and the dyes adsorbed on the surface of the fiber can diffuse into the fiber [2-3]. Chitosan is a non-toxic and chemically reactive, and biocompatible natural functional polymer, and has long been used as a biopolymer and natural material in many fields. Recently, chitosan effects widely

studied are antistatic, bacteriostatic, biocompatibility properties conferred on various textiles [4-6]. According to some previous experiences, wrinkle-resistance finishing with chitosan for fabric can improve its wrinkle degree but its handle and mechanical property got worse to a certain extent. Chitosan adsorption also increased the moisture absorption of the fibers. Chitosan with lower molecular weight increased the hydrophilicity of the treated fibers, but chitosan with higher molecular weight, decreased it [7-8].

Experimental methods

In this research, standart cotton/polyester (CO/PES) fabrics, cryogenically obtained chitosan *Apis Mellifera*, reactive and disperse dyestuffs.

Chitosan is a biopolymer obtained from deacetylation of the abundant natural chitin polymer. It has found its use in many applications due to its unique solubility as well as chemical and biological properties. In addition to its biodegradability and biocompatibility, it has many reactive amino side groups that offer the possibilities of chemical modification and formation of a large variety of beneficial derivatives. It has excellent absorption and biological properties, chitosan present a myriad of opportunities in eco-friendly textile industry [9-10]. In this work, the first part is dedicated to developing the physio-chemical and biological characteristics of chitosan. Dispersants or carriers are added to the dye bath to obtain intense color fastness of polyester fibers [11-12]. These carrier agents can often cause allergic conditions in human skin. In addition, their small amount remaining in polyester fibers reduces the lightfastness of color [13-14]. Disperse dyes and harmful auxiliaries can be eliminated by using a natural polymer such as chitosan in the finishing process of textile fabrics [15-16]. In this work, the processes of dyeing polyester/cotton fabrics in one bath using the dispersed/active dyes method were investigated.

The 80/20 cotton-polyester blend fabric was cleaned and bleached (H_2O_2 35% 4 g/l, 30% NaOH 2 g/l, stabilizer 2 g/l) and dried at 90°C.

Chitosan was prepared in molecular weight (M_w)192 with the degree of deacetylation (DDA) 90 (Table 1).

The characteristic results of different chitosans

Table 1

	Characteristics				
	Dry weight, %	Ash content %	Deacetylation degree, %	Viscosity, mPas	Molecular weight
<i>Chitosan Apis mellifera</i>	90.5	0.8	87.9	4.1	(240)n
Chitosan in N ₂ medium (<i>Apis mellifera</i>)	95.6	0.9	90	3.4	(192)n
Crab chitosan	98.5	1.1	92	17.7	(160.9)n

As can be seen from Table, chitosan synthesized from local raw materials is an important product for the textile industry, because its viscosity and molecular mass have specific properties for the dyeing and finishing process. The degree of deacetylation (DDA) has no effect on the dyeing process, but the molecular weight and viscosity of chitosan are very important that is, the lower the molecular mass, viscosity and solubility of chitosan (table 2), the higher the effect on the dyeing process.

Table of solubility of chitosan from dead bees

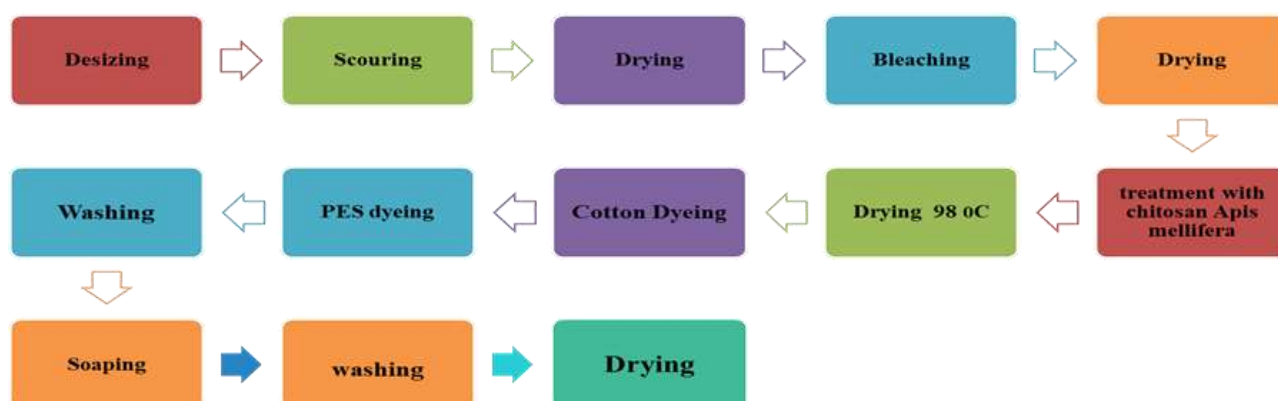
Table 2

	s			
	-	2% -aqueous solution of acetic acid	-	-
<i>Chitosan Apis mellifera</i>				
Chitosan in N ₂				

medium <i>mellifera</i>)	(Apis				
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As can be seen from Table 2, that the solubility of chitosan synthesized in nitrogen atmosphere is higher than the solubility of chitosan synthesized by conventional method. Which does not cause defects in the dyeing process when the fabric is treated with chitosan.

Before dyeing the cotton/polyester mixed fabric is treated with 0.5 %, 1.0%, 1.5%, 2 % and 3.0% chitosan. After the sample fabric is dried at 80°C, 30min and then curing is done at 95°C for 5 minutes. Samples 3 to improve the adhesion of chitosan to the smooth surface of polyester fibers; Pre-treated with a NaOH solution with a concentration of 5 and 10 g/l for 25-30 minutes at 95°C in a liquid ratio of 1:30. Then the samples were washed twice in cold water and dried at 100°C. Three samples of chitosan (dissolved in 2% acetic acid) of different viscosity and degree of deacetylation, synthesized in the laboratory at the Department of General Chemistry of TSTU, were processed. The characteristics of the samples are given in Table. This process was repeated several times to ensure that chitosan was evenly applied to the surface of the fabric. The samples were then dried at 98°C for 40 seconds. If the process is carried out at temperatures above 100°C, it is subjected to a thermosetting process [17-20].



Scheme. Dyeing process of cotton polyester fabric with chitosan

As can be seen from the scheme, each process must be carried out according to the given norms.

Samples impregnated with chitosan in a dye bath began dyeing at 25°C for 15 minutes, then raised to 70-90°C in a dye bath, kept at this temperature for 60 minutes and cooled to 60°C. After 30 minutes at 60 °C, 20 g/l sodium carbonate (Na₂CO₃) was added to fix the reactive dye on the cotton and kept at 60 °C for another 30 minutes. The dyed fabric was washed and dried at room temperature. The color difference between the dyed samples was monitored after different concentration chitosan solution treatment .

Results and discussion

The dyeing with reactive and disperse dyestuffs obtained on chitosan-deposited cotton/polyester fabric samples is even, independent of earlier alkaline pre-treatment. The dyeing uniformity depends on the uniformity of chitosan deposition. The dyed cotton-polyester samples are characterised by better dyeing uniformity effect, which decreases with an increased amount of chitosan. Chitosan-treated, but not alkali-pretreated, cotton/polyester fiber blend fabric samples were uniformly dyed with the resulting disperse/reactive dyes [21]. The uniformity of coloring depends on the uniformity of chitosan treatment. When dyeing samples of dyed polyester/cotton fabrics with increasing chitosan content, the color intensity of the fabrics does not change, and the melange effect decreases [22]. Pre-treatment with alkali affects the adhesion of chitosan to the surface of polyester fibers, which is manifested by the intensity of the color. permissible alkali concentration (NaOH) 10 g/l. Achieving a good effect mainly depends on the amount of chitosan obtained and its characteristics (degree of deacetylation, molecular weight). The higher the molecular weight (viscosity) of the applied chitosan, the worse the effect. The degree of deacetylation of chitosan does not affect the color fastness of the fabric, abrasion and washing speed. The viscosity of chitosan (depending on its molecular weight) determines its consumer properties. The stiffness of samples impregnated with

chitosan increases with increasing deposition of chitosan in the tissue. Based on the conducted experiments, the FTIR spectrum of cotton/polyester (CO/PES) mixed fabric treated and untreated with chitosan *Apis mellifera* were obtained and the results were compared (Fig.A, fig.B).

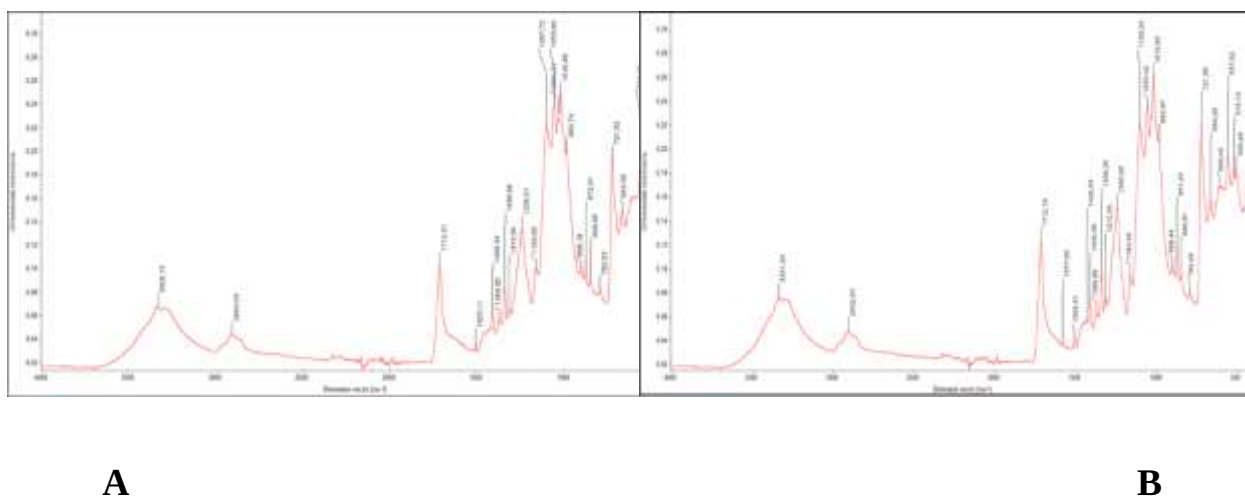


Fig.1. A)FTIR spectrum of Dyed CO/PES mixed fabric with chitosan *Apis mellifera* B) FTIR spectrum of standart dyed CO/PES mixed fabric

The FTIR spectrum of the chitosan treated cotton/polyester mixed fabric dyed with reactive/disperse dye is presented in Figure 1. A. The appearance of a strong broad band at 3330.81 cm^{-1} indicates the characteristics of hydroxyl groups (H-bonded OH stretching), whereas the small peaks at 2899.85 cm^{-1} is characteristic of alkanes. Both spectra show peaks around 1711.99 cm^{-1} associated with the amide I bands (C=O stretching) and near 1575.71 cm^{-1} for amide II bands (N-H bending), which are characteristics of chitosan. The FTIR spectrum of chitosan treated cotton fabric dyed with reactive red dye shows evidence of the presence of various functional groups. The presence of tertiary and secondary amine groups was due to the chitosan treatment of the fabric performed before the dyeing process. These groups got protonated under acidic conditions, producing a positively charged cotton surface, and thus contributed to the attachment of anionic reactive red dye molecules to the cotton fabric, enhancing the dyeability without alkali and salt treatment.

FTIR spectrum of standart dyed cotton/polyester fabric Figure1. B. The broad peak around $3331,93\text{ cm}^{-1}$ indicative of O-H stretching is present in this spectrum as well, a common feature for cellulosic materials which are likely present in the cotton component of the fabric. The alkane C-H stretching peaks near $2902,64\text{ cm}^{-1}$ are also present, which is characteristic of both cotton (cellulose) and polyester components. The fingerprint region below 1577.60 cm^{-1} shows complex patterns in all the spectra, which is typical due to the variety of bonds in the materials. The amide I and II bands (around 1577 cm^{-1} and 1504 cm^{-1} , respectively), which are prominent in the chitosan-treated fabrics, are not as pronounced in this standard dyed fabric spectrum. This suggests that the chitosan's contribution to these particular peaks is significant in the treated fabrics.

The intensities of the peaks vary between the two spectra fig.1.A. and fig.1.B., which could be due to differences in the concentration of the components, the thickness of the sample, or the degree of interaction between the chitosan and the textile fibers. Moreover, some minor peaks present in one spectrum may not be as prominent in the other, which suggests that there might be additional chemical groups present or a different arrangement of molecules on the surface of the fibers. The standard dyed fabric likely lacks the biochemical components of chitosan, which results in a spectrum with fewer peaks associated with biological molecules. The differences in peak intensities and positions between the standard dyed fabric and the chitosan-treated fabrics can be used to infer the presence and effect of the chitosan treatment. The mechanical properties of CO/PES fabrics after chitosan implementation and the washing process were analyzed through the tensile properties and mechanical damage.

Achieving a good effect mainly depends on the amount of chitosan obtained and its characteristics (DDW). Based on the conducted experiments, the SEM analysis of cotton/polyester (CO/PES) mixed fabric treated and untreated with chitosan *Apis mellifera* were obtained and the results were compared (fig.2).

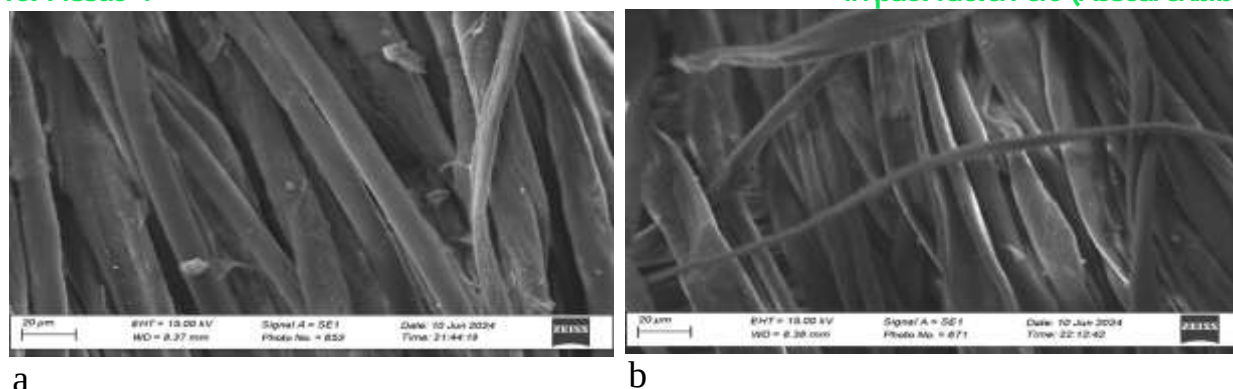


Fig.2 a)SEM analysis of cotton/polyester blend fabric treated with chitosan *Apis mellifera* b)SEM analysis of Dyed CO/PES mixed fabric untreated with chitosan *Apis mellifera*

From the SEM images of PES/CO fabric, the difference in morphology of fibers in the blend can be clearly seen: CO fibers' morphological structure show the appearance of a flat ribbon with a central canal in comparison to the PES even flat smooth surface. The mechanical properties of CO/PES fabrics after chitosan implementation and the washing process were analyzed through the tensile properties and mechanical damage.

Conclusions

In this work described the ability to dye cotton/polyester mixed fabric in one step, one dyeing bath with shortened time. It was found that the pretreatment of cotton/PE mixed fabrics with chitosan nanoparticles enhanced the dye uptake and also increased the antibacterial activity of cotton/PE fabrics compared with untreated fabric. The improved dye ability of cotton to acid dye is postulated due to the presence of amide groups available from the chitosan. Based on the depth of shade values, it was found that by increasing chitosan concentration, there was significant improvement of relative color strength. Moreover, colorfastness properties to washing and wet crocking of the treated samples were improved. Union dyeing of cotton/ PE fabrics with acid dyes using biodegradable modification agent such as chitosan is an environmental friendly approach in the field of textile dyeing industry.

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