MODIFICATION OF CHITOSAN FIBERS BY ORGANIC ACIDS VAPORS

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EXTENDED ABSTRACT

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1. INTRODUCTION

Due to the growing problems with pollution green chemistry is increasingly being considered as a way out of the situation. Green chemistry is designed to design chemicals and safer processes, reducing the risk of interactions for people, minimizing the environment pollution, reducing the unhealthy effects of chemicals. It is efficiently using regenerable and renewable materials. Considering this fact organic polymers that are among other natural sources, are ideal feedstock and have been used respectively [1]. One of these biodegradable polymers is chitosan. Chitosan is a biopolymer which is a derivative of chitin, widely available in various forms in various branches of industry. It can be used in a wide range of applications such as in the areas of biomedicine, membranes, drug delivery systems, hydrogels, water treatment, food packaging [2]. Chitin is a polysaccharide one of the most common in the natural environment. It can be found in sea shells of invertebrates, insects and fungi [3,4]. Chitosan is a versatile material that can be molded in various ways such as membranes, hydrogels, tubes, fibers or spheres [5]. The cationic properties of chitosan obtained in the acid environment gives it unique properties among existing polysaccharides. Chitosan acetate in the cationic form is safe to use, non-toxic and biodegradable. The chitosan salts of organic acids such as chitosan acetate and chitosan formate have good solubility in water. The most popular solvent for chitosan is 5% solution of acetic acid. Dissolved chitosan in acetic acid solution is usualy used in the formation of foils and fibers. The system of dissolved acetate chitosan salt has found application as a bacteriostatic component in the Tromboguard dressing, which is an commercial product of the company Tricomed S.A. Poland. The aim of the presented work was to prepare and to determine the physicochemical properties chitosan salts being the derivatives of formic acid, acetic acid, propionic acid, butyric acid hydro chloric acid present in fibrous form.

2. MATERIAL AND METHODS

2.1 Materials

Chitosan fibers were a commercial product of Hismer Bio-technology Co., Ltd, China. The nonwoven structure has been produced by a classical nonwoven technique in which the fleece is formed from staple fibers of biodegradable chitosan material by a carding system. For the formation of nonwovens fibers with a linear density of 2.02 dtex with a strength of 12 cN/tex and a relative elongation of 1.5% were used.

The machine was fed with fiber in the amount of 30 g/field of the supply ladder and an elementary web was created with a surface mass of 9.8 g/m^2. The elementary run was assembled to obtain a surface mass of 150 g/m^2. The final nonwoven fabric was obtained by combining four layers of elementary fleece. Solutions of organic acids with specific purity for analysis were used in the form of ready solutions obtained from the producer, POCh Poland.
A typical procedure for modifying chitosan fibers in the form of nonwovens was as follows.
A 10 g nonwoven sample was placed in a 3 dm^3 desiccator, in which there was a vaporizer containing 10 cm^3 of the corresponding acid. After 24 hours, the nonwoven sample was removed from the atmosphere.

2.2 Methods

The chemical structure of chitosan derivatives has been confirmed by instrumental methods - Fourier Transform Infrared - Attenuated Total Reflectance (FTIR-ATR) spectroscopy.

3. EXPERIMENTAL RESULTS AND DISCUSSION

The changes in the structure and chemical composition of the chitosan fibres were investigated by Fourier Transform Infrared - Attenuated Total Reflectance (FTIR-ATR) spectroscopy on a FTIR NICOLET 6700 firmy Thermo Scientific. The spectra were the average of 32 scans at resolution 4 cm^{-1}. The FTIR ATR spectra example of chitosan as well as chitosan salt of propionic acid are shown in figure 1.

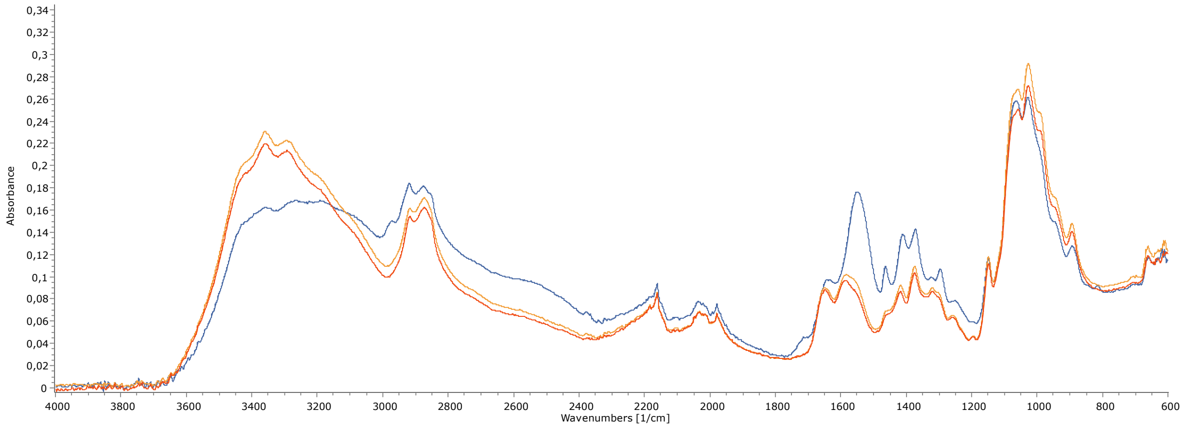

Figure 1 FTIR ATR spectra of chitosan fibres (red line), chitosan fibres after 30 min (orange line), chitosan fibres after 2 hours of exposition on propionic acid vapors (blue line)

It can be seen in the spectra shown, there are differences confirming the formation of a derivative of the propionic acid salt and chitosan after 2 hours of interaction of the organic acid in gas phase. There is visible weak signal of carboxylic groups derived from propionic acid adsorbed on the surface of chitosan fibers with a maximum of 1716 cm^{-1}. Adsorption of propionic acid gas may occur as a result of the interaction of hydrogen bonds between the hydroxyl groups of chitosan with the COOH group of the organic acid. After 2 hours of exposure to the gaseous propionic acid phase, an intense peak appears with the maximum at 1550 cm^{-1}, probably derived from the forming group of the ammonium salt of propionic acid and chitosan.

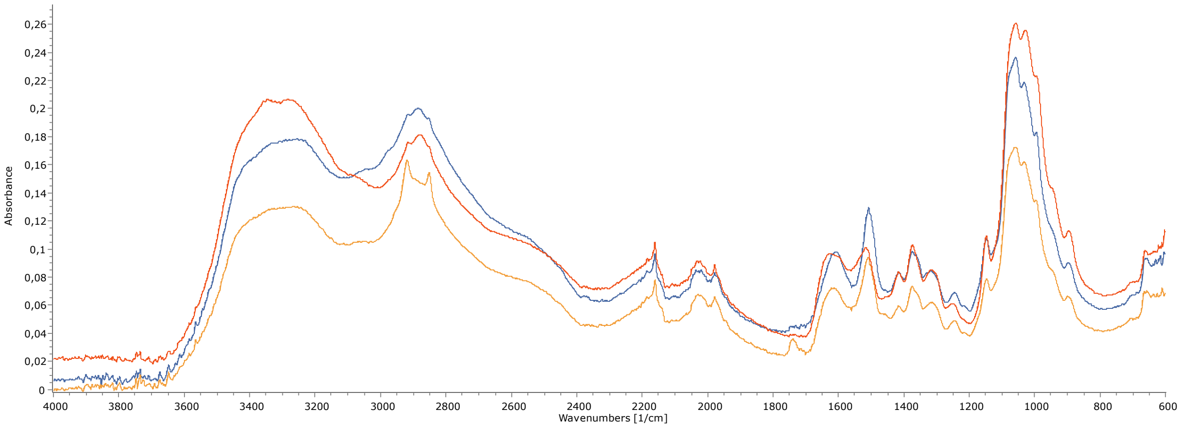

Figure 2 FTIR ATR spectra of chitosan fibres (red line), chitosan fibres after 30 min (orange line), chitosan fibres after 2 hours of exposition on hydro chloric acid vapors (blue line)

In the spectrum of FTIR ATR chitosan fibers treated with hydrochloric acid in the gas phase appears in the comparison of the amplified signal with the maximum at 1506 cm^{-1} corresponding to the forming ammonium group of chitosan hydrochloride. Similar changes are observed on the non-visible spectra of chitosan fibers treated with other organic acids in the gas phase.

4. CONCLUSION

The implementation of proposed methodology of chitosan fibres modification leads to the develop of the method for obtaining chitosan salts in the fibrous form without forcing them to dissolution process in water solution during formation the salt of appropriate acid.
The course of the fiber formation process from the chitosan salt of appropriate organic acid as well as inorganic acid was can be monitored by means of ATR FTIR spectroscopy. Analysis of chemical composition of the obtained derivatives allowed to approve the existence of the dependence of the rate of salt formation on the chemical structure of organic acid.

5. REFERENCES.

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