ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

STUDY OF THE EXPERIMENTAL CONDITIONS IN BIOSCOURING TREATMENT OF COTTON-HEMP BLENDED FABRICS

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Abstract: *The main objective of the pretreatments applied in textile industry is to remove all native impurities present in the natural fibers. The nature and quantity of noncellulosic compounds present in hemp and cotton fibers is variable. These have hydrophobic characteristics which negatively influence the fabrics hydrophilicity. Depending on their nature these can be eliminate by a simple wash procedure or if we think at those of chemical nature more advance methods need to be performed.*
In the study, the result obtained after applying a bioscouring treatment on 50 % of hemp-50 % of cotton blended fabrics are presented. The aim of the procedure was the elimination of physical and chemical compounds presented in the fabric for the improving of its technological characteristics.
A pectinolytic commercial product (Beisol PRO) was used, varying its concentration. The reaction bath contained phosfate buffer solution of 0.1 M and pH 8, 2 g/L complexing agent (EDTA) and 0.5 % surfactant (Denimcol Wash RGN). The bioscouring treatments were performed using a central, rotatable second order compound program with two independent variables: Beisol PRO concentration (between 1-3 % o.w.f) and exposure time (15-55 minutes) at 55°C. The liquid to faric ratio was 20:1. The following parameters were determined: weight loss, hydrophilicity, calcium content, whiteness and yellowness index.
The obtained results underline the efficiency of the considered method. The pectinolytic procedure applied on the hemp-cotton materials has contributed to pectin hydrolysis and optimum removal of undesired impurities with minimum fabrics degradation.

Key words: *cotton-hemp material, enzymatic treatment, pectinolytic commercial product, calcium quantity*

1. INTRODUCTION

The main objective of the pretreatments applied in textile industry is to remove all native impurities present in the natural fibers to improve their technological properties. The nature and quantity of noncellulosic compounds present in hemp and cotton fibers is variable. These have hydrophobic characteristics which negatively influence the fabrics hydrophilicity. Depending on

their nature, these can be eliminated by a simple wash procedure or if we think at those of chemical nature more advance methods need to be performed.

Classical scouring presents a series of advantages but also some important disadvantages. The alkaline treated fabrics show improved characteristics as wettability or chromatic indexes [1], but also a mass loss increase which is determined by advanced fiber degradation. This last aspect influences the materials behaviour in future processes by affecting their chemical and thermal stability [2]. Another aspect which should not be neglected is the environmental one. The scouring treatment implies utilisation of large quantities of harmful chemicals and hight costs.

A viable alternative is represented by the bioscouring. The procedure consists in application of specific mixture of enzymes in order to hydrolase principally the pectins and the lignin presented in the bast fibers [3, 4]. Using modern scanning technologies, it has been proved that the ecofriendly methods improve fibers surface smoothness degree by advanced impurities elimination with less or non fiber degradation [5].

2. EXPERIMANTAL PART

For the pretreatmens were used 13 models, varying the enzyme quantity and treatment time. The determined parameters value also included the raw blended fabric and water washed one (the control).

The hemp-coton blended fabric has the following characteristics: width (120 ± 3 cm), weight (220 ± 10 g/m^2), warp density (10 fibers/cm), weft density B (10 fibers/cm), Nm 14 for warp direction and 50 % of hemp + 50 % of cotton yarn, Nm 14 for weft direction, 100 % of cotton yarn.

All tests were initially prepared for the bioscouring. These were washed at 100°C in an AATCC standardized Lander-Ömeter, model M228-AA from SDL Atlas Company-US [4], air dried, conditioned in controlled atmosphere and weighed. The bioscouring treatment steps are presented in Figure 1.

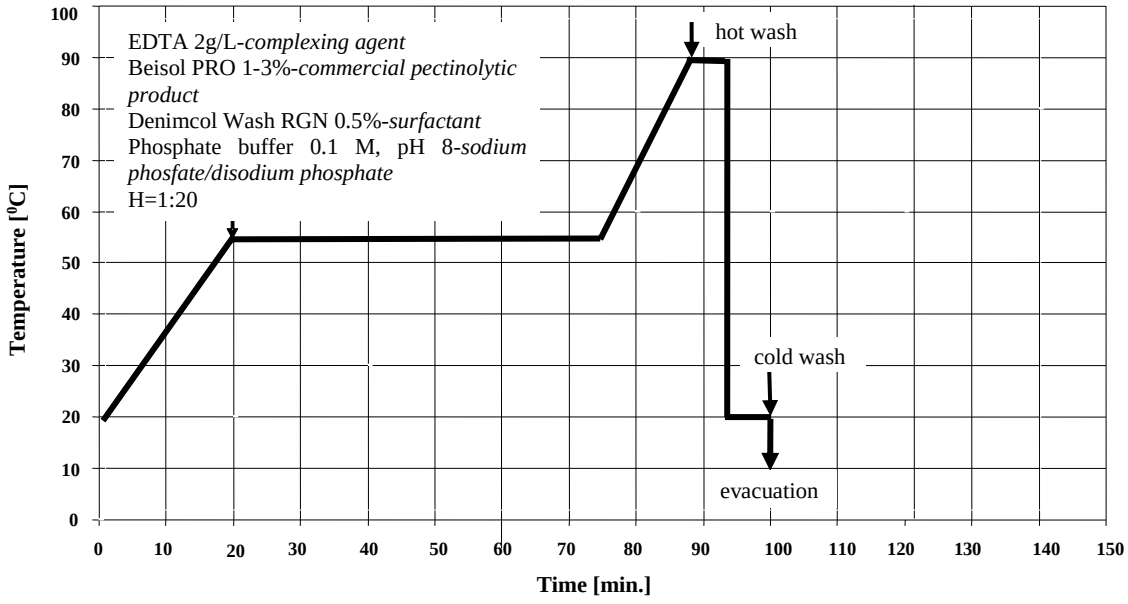

Fig. 1: *The bioscouring diagram*

The efficiency of the proposed pretreatment procedure was verifyed establishing the value of some important reference parameters: hydrophilicity, weight loss, calcium quatity, whiteness and yellowness degree.

RESULTS AND DISCUSSIONS

The values registered for hydrophilicity after enzymatic treatments are presented in Table 1.

Table 1: *Hydrophilicity registered for samples enzymatically treated in different conditions*

Sample	Enzyme concentration [%]	Treatment time [min.]	Hydrophilicity [s]
1	1.30	21.00	1.50
2	2.70	21.00	1.45
3	1.30	49.00	0.85
4	2.70	49.00	0.80
5	1.00	35.00	1.60
6	3.00	35.00	1.15
7	2.00	15.00	1.80
8	2.00	55.00	0.98
9	2.00	35.00	1.40
10	2.00	35.00	1.48
11	2.00	35.00	1.35
12	2.00	35.00	1.39
13	2.00	35.00	1.46
Control	-	60.00	120.00
Raw fabric	-	-	>500.00

The data presented in Table 1 show the effieciency of the pectinolytic treatment, with hydrophilicity values under 2 sec. (maximum value is **1.80** sec. at *2* % enzymatic product concentration and *15* min. treatment time). All bioscoured samples have a very good hydrophilicity compared with the control (*120.00* sec.) and raw fabric (*>500* sec). This parameter is relevant for further finishing processes and final destination of the material. The bioscouring process improves the fabrics cleaning processes and also contributes to lower fiber degradation.

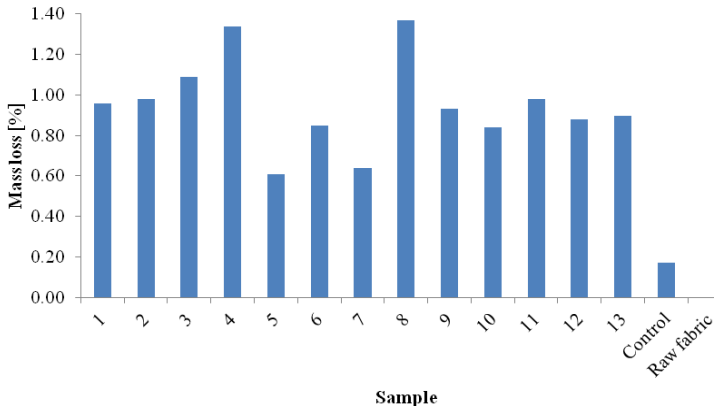

Fig. 2: *The mass loss of samples enzymatically treated in different conditions*

As shown in Figure 2, the higher mass loss is observed for samples *4* and *8* namely for the longest treatment time (*49* respectively *55* minutes). In all cases, it can be observed a linear dependence between the weight lost and the process parameters *enzyme quantity* and *exposure time*. Independent of the two variables the presented values decrease is lower than 1.5 %. Our results are sustained by data presented in the literature. The eco friendly treatments have a lower effect on the cellulosic structure of the natural fibers compared with the classical alkaline one [6]. This is a desirable outcome regarding the pretreatments applied on natural fibers, more accurate to remove non cellulosic components and with minimum cellulose degradation.

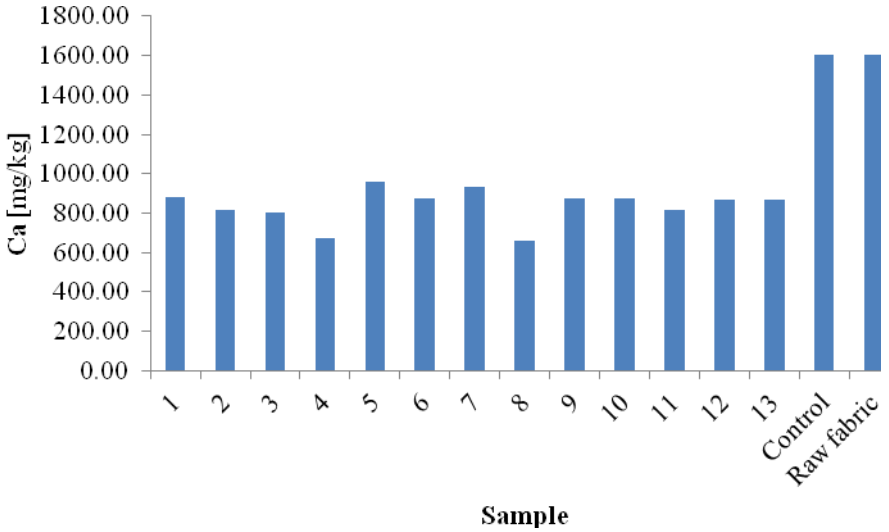

Fig. 3: *The calcium quantity determined for samples enzymatically treated in different conditions*

Hemp fibres have a heterogen chemical structure. Pectins represent around 1% of the other noncellulosic components [7]. They are presented in the cuticula and primarily plant cell walls. From chemical point of view pectins contain residues of 1, 4-linked α-D-galactosyluronic acid [8] which form three important polysaccharides chains: homogalacturonan, rhamnogalacturonan-I, and substituted galacturonan, linked throught Ca^{+2} bridges. Their solubilisation has been evidenced after treatment with aqueous buffers solutions and calcium ions chelators [8]. Our pretreatmens had been made using phosphate buffer 0.1, pH 8 in presence of EDTA. From figure 3 it can be observe that the quantity of Ca presented in the bioscoured samples is with approximately 50% lower compared to the untreated samples. In these situation, we can underline the hydrolytic efficiency of the pectinolytic treatment in removing the pectins from the fibres.

Using the Datacolor 500 spectrophotometer the whiteness and yellowness degree was measured for all enzymatic treated 13 samples, the control and the raw one. The two indexes were automatically calculated by the Datacolor Tools 2.0 software [7]. The reflectance (R%) was measure at 420 nm. The values obtained were compared with a barium sulphate white standard. In all cases the whiteness index registered has higher values compared with the control and raw fabric. Between the pretreated samples, the two indexes variation is lower but in compare with the control the whiteness index is almost two times higher reaching 59.02% in case of sample 8. Regarding the yellowness, the minimum value is approximately 50% of the one determined in case of the raw material.

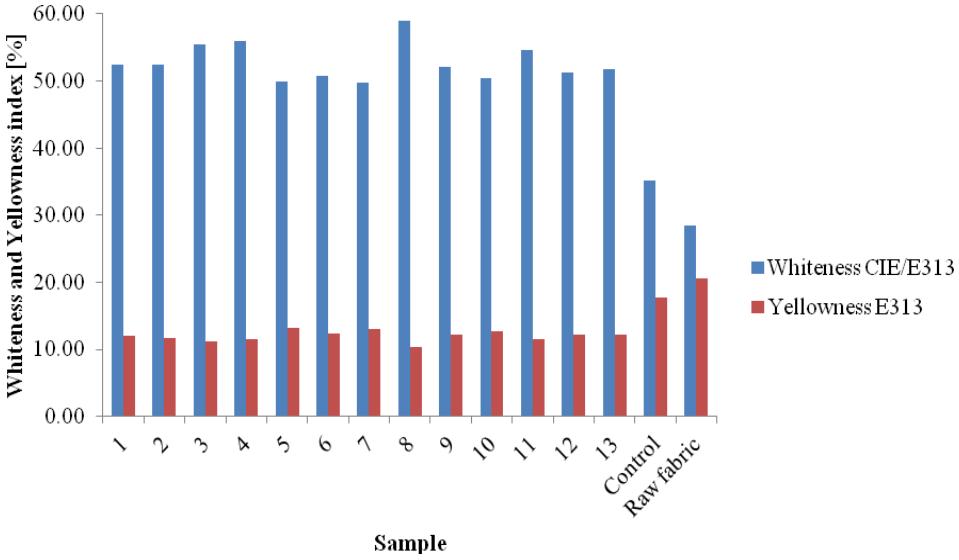

Fig. 4: *The whiteness and yellowness index for samples enzymatically treated in different conditions*

5. CONCLUSIONS

Summarizing the results of the investigations made, we can conclude the following:

- For all enzymatic treated samples was demonstrated the efficiency of the applied treatments. All hydrophilicity values are under 2 sec. (the higher value is 1.80 sec. at 2 % enzymatic product concentration and 15 min. treatment time) compared with the control (120.00 sec.) and raw fabric (>500 sec). These show an important wettability increase.
- As consequence of the proposed procedure we also notice a mass loss in all 13 cases analyzed. For sample *8* this parameter value (**1.37**%) is with 87.6% higher compared to the control sample (0.17%). All determined values are lower than **1.4**%. This is an effect of a proper removing of non cellulosic constituents and also a low degradation of the material.
- The decrease of calcium quantity presented in the bioscoured samples evidence the positive influence of the reaction mixture which contained phosphate buffer, EDTA as chelating agent and pectinolytic complex which led to pectin hydrolysation and calcium ions releas.
- The bioscouring treatment positively influenced the values of the chromatic indexes determined. The whiteness index reached almost 60%. The yellowness index value is approximately half from the control one.

ACKNOWLEDGEMENT

This work was supported by a grant of the Romanian National Authority for Scientific Research and Innovation, CNCS-UEFISCDI, project number PN-II-RU-TE-2014-4-1370, and

„Centru de Cercetare în Științe Tehnice și Naturale-CESTN" co-funded by European Union through European Regional Development Fund Structural Operational Program "Increasing of Economic Competitiveness" Priority axis 2. Operation 2.2.1. POSCCE Nr. 621/2014 POS-CCE.

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