ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

PART II. STUDY REGARDING THE INFLUENCE OF BIOSCOURING TREATMENT ON 60 % COTTON + 40 % COTTONISED FLAX MATERIALS FOLLOWED BY A WHITENING TREATMENT USING ALTERNATIVE METHODS

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Abstract: *A comparative study of whitening treatment using various methods for 60 % cotton +40 % flax materials was made. The samples materials were scoured by bioscouring treatment in ultrasound as was described in our previous work (part I). The removal of noncellulosic impurities using the bioscouring treatment was evaluated by weight loss and hydrophilicity of the treated samples. Some of these bio-scoured samples were further bleached using the folowing procedures: Classical procedure with hydrogen peroxide (30 %), bleaching with catalyst and with laccase enzyme.*
Hydrogen peroxide is usually used as oxidative bleaching agent for cotton and cotton blends. A high and stable degree of whiteness is obtained by this treatment. The advantages of the treatment are: low costs, flexibility of application and the possibility of a one-bath (scour/bleach) procedure. But, high temperature of bleaching under alkaline conditions necessitates high energy utilization that can cause considerable fiber damage. Different solutions like the use of enzymes and catalysts have been investigated to overcome such problems. In order to characterize the quality of the enzymatic pretreatment compared to the classical one, the values of the whiteness degree after different type of bleaching (hydrogen peroxide, catalyst and laccase) for the samples treated with the same concentration of enzyme were studied. The tensile strength and elongation at break of treated materials were investigated.

Key words: *cotton, flax, bioscouring treatment with ultrasound, weight loss, alternative whitening methods, whiteness degree*.

1. INTRODUCTION

Hydrogen peroxide is usually used as oxidative bleaching agent for cotton and cotton blends. A high and stable degree of whiteness is obtained by this treatment. The advantages of the treatment are: low cost, flexibility of application and the possibility of a one-bath (scour/bleach) procedure. But, high temperature of bleaching under alkaline conditions necessitates high energy utilization that can cause considerable fiber damage. Different solutions like the use of enzymes and catalysts have been investigated to overcome such problems [1]

After the removal of noncellulosic impurities using the bioscouring treatment, the material becomes much cleaner and hydrophilic with better absorbent properties. By whitening treatment, the whiteness degree it is considerably improved because the chromophore groups of the natural pigments from cotton and flax are destroyed by oxidation reactions. Bleaching may be carried out by using several procedures like classical method with hydrogen peroxide or enzymatic method with different type of enzymes.

2. EXPERIMENTAL PART

The experiments were carried out using samples fabrics treated by bioscouring method presented in the first part. The bioscouring treatment was done with a commercial enzyme called SERA ZYME C-PE in the presence of ultrasound in a multi-frequency ultrasonic cleaning unit; model TI-H-10 from Elma Schmidbauer GmbH, Germany. The energy of sonication applied was 200 W (ultrasonic power effective) and 800 W (ultrasonic peak performance max). The commercial enzyme product contains a Pectate Lyase with the calsiffication E.C. 4.2.2.2. A sequestering agent with the role of binding the metal ions in water was used. The agent was HEPTOL NWS in 2 mL/L concentration. The wetting and scouring agent SULFOLEN 148 of 2 mL/L concentration was added. 10 % of the fleet treatment was pH 7.5 buffer solution (0.1 molar sodium dihydrogen phosphate/disodium hydrogen phosphates). The experiments were conducted in a fabric to liquid ratio 1:10, at the temperature of 55 ^{0}C and a variable time between 20-60 minutes [2].

The bleaching treatments applied to the scoured samples were carried out under the following conditions: [3, 4, 5, 6]

- *Classical procedure*: 3 mL/L hydrogen peroxide (30 %) + 1 g/L NaOH + 4.5 mL/L sodium silicate; fabric to liquid ratio – H - 1:20; Temperature = 90-95 ^{0}C; time = 40 min.
- *Procedure with catalyst*: 3 mL/L of catalyst solution prepared from 1 g of catalyst + 1.5 mL 30 % hydrogen peroxide); fabric to liquid ratio – H - 1:20; Temperature = 60 ^{0}C; time = 40 min.
- *Procedure with laccase enzyme*: 3% o.w.f. (over fiber) commercial Laccase - Lava Zyme LAC, wich is a suitable enzyme for bleaching of cellulosic materials + buffer 0,1 molar acetic acid/sodium acetate (pH = 5); fabric to liquid ratio – H - 1:20; Temperature = 60 ^{0}C; time = 40 min.

The evaluated properties of 60 % cotton + 40 % flax materials bioscoured according to the experimental program [7] presented in the first part are presented in Table 1.

Table 1: *The properties of cotton 60 % + flax 40 % materials after the bioscouring treatment*

Samples	Enzyme concentration (%)	Weight loss (%)	Hydrophilicity (s)	Whiteness degree R (%)
1	1.70	3.04	4.6	43.78
2	2.70	1.59	3.4	46.23
3	1.70	2.85	5.2	47.55
4	2.70	1.25	3.2	45.03
5	1.00	3.55	7.8	46.35
6	3.00	1.11	6.0	45.58
7	2.00	2.06	4.4	46.48
8	2.00	2.18	4.0	46.43
9	2.00	4.03	9.6	46.80
10	2.00	2.57	7.2	45.78
11	2.00	1.4	7.2	47.35
12	2.00	1.39	10.4	45.55
13	2.00	1.89	5.0	44.35

The samples 10, 11, 12 and 13 (pretreated in the same conditions: 2 % enzyme concentration for a time of 40 minutes) were further bleached as described in table 2.

Table 2: *The Corespondence between pretreated samples and bleaching treatments applied.*

No.	Samples	Bleaching type
1.	10	Classical
2.	11	Catalyst
3.	12	Laccase
4.	13	Control

The efficiency of the alternative bleaching treatments compared to the classical one was established by measuring the following characteristics of the treated samples: 1) the whiteness degree R (%), 2) weight loss (%) and 3) hydrophilicity (seconds) as shown in table 3, as well as 4) the tensile strength [N] and 5) elongation at break [%] as shown in the table 4. The values of the whiteness degree were studied after different type of bleaching (hydrogen peroxide, catalyst and laccase) for the samples treated with the same concentration of Pectate Lyase enzyme SERA ZYME C-PE.

Table 3: *Comparative characterization of bleaching treatments on the bioscoured samples*

No	Samples	Type of bleaching	Treatment conditions	Weight loss (%)	Hydrophilicity (seconds)	Whiteness degree R (%)
1.	10	Alkaline bleaching	1:20 fabric to liquid ratio Temperature 90-95^{0}C time - 40 min 3 mL/L H_2O_2 (30 %) 1 g/L NaOH 4.5 mL/L Na_2SiO_3	2.53	2	63.38
2.	11	With Catalyst:	Fabric to liquid ratio H = 1:20 Temperature = 60 ^{0}C time = 40 min 3 mL/L of the catalyst (solution prepared from 1 g catalyst + 1.5 mL 30% H_2O_2	0.75	2	49.33
3.	12	With laccase enzyme	Fabric to liquid ratio H = 1:20 Temperature = 60 ^{0}C pH = 5 of 0.1 molar buffer of acetic acid / sodium acetate time = 40 min 3 % o.w.f. commercial Laccase	0.39	2	47.60
4.	13	Control	Fabric to liquid ratio H = 1:20 Temperature = 60 ^{0}C time = 40 min	0.16	3	46.33

To evaluate and compare the degradation occurred during the enzymatic preatreatment of cellulosic fabrics, before and after bleaching with enzymes, catalyst and classical method, measurements of the tensile strength and elongation at break for the treated 60 % cotton + 40 % flax material were performed. [8]

Table 4 presents the results of tensile strength and elongation at break for the treated sample fabrics.

Table 4: *Determination of the tensile strength after different bleaching treatments*

No.	Samples	Tensile strength [N]	Elongation at break [%]
1.	Classical	498.5	16
2.	Catalyst	619.9	17.9

3.	Laccase	621.2	20.1
4.	Control	673.9	21.1

The alkaline bleaching treatment shows a higher weight loss compared with the other samples treated with catalyst or laccase. For the all samples the hydrophilicity is the same. The whiteness degree obtained after the classical treatment is higher, followed by catalyst treatment and laccase one. According with the values of the tensile strength the tratment with catalyst caused a slight fiber damage comparing with the treatment with laccase.

3. CONCLUSIONS

During the studies carried out it was found that the alternative methods shows a promising and viable ecological solution for bleaching of cellulosic, lignocellulosic fabrics and mixtures of thereof. Moreover, these treatments are more environmentally friendly by less energy consumption and water pollution and less destructive to the fabrics by a small decrease of their tensile properties which means a minimal amount of fiber damage.

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

''Bast plants - Renewable Strategic Resources for European Economy - BASTEURES'' project, no. 210/2010 POS-CCE - supported by Structural Founds - "Investment in Your Future".

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