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DETERMINATION OF WEIGHT LOSS OF KNIT FABRICS IN COMBINED SCOURING-BLEACHING AND ENZYMATIC TREATMENT

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ABSTRACT

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The aim of the work was to measure the weight loss of cotton knitted fabrics in combined scouring-bleaching and enzymatic treatment. 100% cotton knitted single jersey fabrics were scoured-bleached at the Wet Processing Laboratory of Ahsanullah University of Science and Technology using H_2O_2 at variable concentrations (2 g/l, 4 g/l and 6 g/l) and certain period of time (30 min, 60 min and 90 min). It was observed that weight loss% was less (1.49%) at less concentration (2 g/l H_2O_2) using short period of time (30 min) and increased (13.97%) using the high concentration (6 g/l H_2O_2) with long period of time (90 min). Also weight loss% was found less (2.01%) at 0.25% concentration of enzyme with lower time of treatment (30 min) and increased gradually with increasing concentration and time of enzymatic treatment.

Keywords: *impurities, weight loss, H_2O_2, cellulase*

INTRODUCTION

Cotton fabric has several impurities such as fats and waxes, pectinous substances, proteinous matter, ash etc. Presence of fats and waxes in cotton fabric imparts poor water absorbency. In order to remove these impurities, scouring of cotton fabric is normally carried out with strong alkali at high temperature and for longer duration. Although, this treatment gives very good results, one of the problems is high loss in weight of cellulosic material (Sorbe Biotechnology 2005). The total amount of impurities to be removed is less than 10 % (about 5 to <10 %) of the total wt (Choudhury 2006). On the other hand, bleaching removes any unwanted colour from the fibres. This process also eliminates any traces of other impurities remaining from the previous preparation steps and improves the absorbency of the material for dyeing and printing (Broadbent 2001). During bleaching process it is unexpected to loss excessive wt. of fabric because; excessive weight loss in bleaching can reduce fabric strength, durability and dimension (Tailfer 1998). Again, in the enzymatic treatment, producers of textile enzymes recommend dosages of approximately 0.05 to 6% of cellulase preparation on garment weight depending on the desired result, the treatment method and the activity of the enzyme product (Heikinheimo 2002). Due to the un-optimized cellulase composition and high dosages, significant weight and strength losses can occur. Commercially a weight loss of 3-6% and strength loss of about 10% is considered acceptable (Choudhury 2006). A suitable bio-polishing effect without excessive loss of fabric strength is generally obtained with 3.5% weight loss of fabric (Heikinheimo 2002). Amount of raw material is reflected by the wt. or GSM (g/m^2) of fabric, which must be maintained for garments. If the excessive wt. loss occurs in the pretreatment, then GSM will be reduced significantly, it will definitely affect the garment quality. In case of high concentration of H_2O_2 or enzyme in the pretreatment processes, chemical cost will be increased. Again, if the wt. loss is less than the standard mentioned, then impurities will remain in the substrate which will create absorbency problem during the combined process. Light bio-polishing may not be effective enough to remove fuzz and the presence of fuzz leads to fabric problems in wear, notably pilling and a frosted appearance, which causes an apparent loss of colour (Heikinheimo 2002). Moreover, heavy bio-polishing will degrade cellulose causing excessive wt. loss. That's why; standard wt. loss in the pretreatment processes must be controlled by setting up proper chemical concentration, pH, temperature and time of treatment for optimum production and good quality garments.

COMBINED SCOURING-BLEACHING OF COTTON

In the combined scouring-bleaching of cotton, the scouring process is accelerated in the presence of H_2O_2 and less time is generally required to achieve good absorbency of the material (Choudhury 2006). The advantages of this process are increased production with reduction of labour cost and reduced treatment time; the loss in wt. and strength of material is less (Choudhury 2006). H_2O_2 is a powerful oxidizing agent that rapidly destroys the natural colouring matters present in cotton without undue oxidative damage to the fibres (Broadbent 2001). Full use of the stabilizing properties of natural cotton impurities minimizes peroxide consumption during bleaching. High alkalinity at elevated temperatures produces efficient scouring action. Bleaching and leveling residual waxes are also affected in this process. Hence a combined scouring bleaching process for cotton using peroxide in winch and package has gained commercial success (Shenai 1995).

ENZYMATIC TREATMENT OF COTTON

Bio-polishing with Cellulase Enzyme

Cellulase is a complex natural mixture of different components, which work synergistically to degrade cellulose to glucose (Enzyme Technology 2002). Knitted fabric in circular form is very difficult to singeing. But the surface of the fabric can easily be cleaned by bio-polishing process. The main advantage of bio-polishing is the prevention of pilling (Olsen 2004). The surface modification of cellulosic fabrics confers cooler and softer feel, brighter luminous color using cellulases (Choudhury 2006). Bio-polishing is getting tremendous popularity due to its effectiveness and process simplicity.

Application Conditions of Enzyme

The enzyme activities increase with temperature, but above a particular temperature the thermal agitation disrupts the tertiary structure of enzymes. Acid cellulases exhibit the greatest activity generally in the pH range of 4.5-5.5 at 45-55°C, whereas neutral cellulases require a pH 5.5-8.0 at 50-60°C. Generally a prolonged treatment time, excessive cellulase dosage and vigorous agitation may increase the fibre loss significantly. Where acid cellulase predominates required washing time is short (20-45 min), whereas for neutral cellulase longer wash time (45-120 min) is required (Choudhury 2006).

MATERIALS AND METHODS

Materials: 100% Cotton S/J 30^s Ne fabric

Methods: Combined scouring-bleaching was performed using different concentrations (2 g/l, 4 g/l and 6g/l) of H_2O_2 with variable time (30 min, 60 min and 90 min). At the end of this process, peroxide killer was added followed by neutralization of caustic soda and then given a hot wash and cold wash. Enzymatic treatments were performed with Biopolish EC at different concentrations (0.25%, 0.5% and 1%) with variable time (30 min and 60 min). The treated fabric samples (both for scoured-bleached and enzyme washed samples), after washing, were dried at 100°C for 2 hrs and conditioned properly before wt. measurement.

Table 1. Recipe of Combined Scouring -Bleaching of Cotton (Hossain 2009)

Recipe using less amount of H_2O_2	Recipe using medium amount of H_2O_2	Recipe using heavy amount of H_2O_2
H_2O_2 (35%) : 2 g/l Kieralon OL: 0.5 g/l (As Wetting agent and Detergent) EDTA disodium salt (99%): 0.5 g/l (Sequestering agent) Caustic Soda (>97%): 2.5 g/l Sodium silicate: 2 g/l Temperature: 95°C Time: 30 min, 60 min and 90 min pH: 10-11 M: L =1: 50	H_2O_2 (35%) : 4 g/l Kieralon OL: 0.5 g/l EDTA disodium salt (99%): 0.5 g/l Caustic Soda (>97%): 2.5 g/l Sodium silicate: 2 g/l Temperature: 95°C Time: 30 min, 60 min and 90 min pH: 10-11 M: L =1: 50	H_2O_2 (35%) : 6 g/l Kieralon OL: 0.5 g/l EDTA disodium salt (99%): 0.5 g/l Caustic Soda (>97%): 2.5 g/l Sodium silicate: 2 g/l Temperature: 95°C Time: 30 min, 60 min and 90 min pH: 10-11 M: L =1: 50

Table 2. Recipe of Enzyme Treatment

Recipe using less amount of Enzyme	Recipe using medium of amount Enzyme	Recipe using heavy amount of Enzyme
Biopolish EC: 0.25 % (o.w.f.) Acetic acid (100%): 0.5 g/l Temperature: 55^0C Time: 30-60 min pH: 4-5 M:L =1:25 Hot wash: 90^0C for 10 min	Biopolish EC: 0.50 % (o.w.f.) Acetic acid: 0.5 g/l Temperature: 55^0C Time: 30-60 min pH: 4-5 M:L =1:25 Hot wash: 90^0C for 10 min	Biopolish EC: 1 % (o.w.f.) Acetic acid: 0.5 g/l Temperature: 55^0C Time: 30-60 min pH: 4-5 M:L =1:25 Hot wash: 90^0C for 10 min

RESULTS AND DISCUSSION

The wt. loss of knitted fabrics in combined scouring-bleaching and enzyme treatment was calculated from the following formulas.

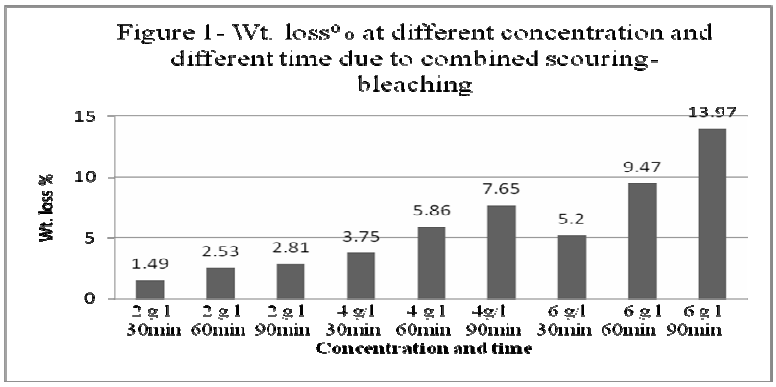
$$\text{Wt. loss \%} = \frac{\text{Wt.before combined scouring-bleaching} - \text{Wt.after combined scouring-bleaching}}{\text{Wt.before combined scouring-bleaching}} \times 100 \quad (1)$$

$$\text{Wt. loss\%} = \frac{\text{Wt.before enzyme treatment} - \text{Wt.after enzyme treatment}}{\text{Wt.before enzyme tretament}} \times 100 \quad (2)$$

Table 3. Wt. loss of the combined scoured-bleached knitted fabrics

SI. No.	Concentration of H_2O_2 (g/l)	Time (min)	Wt. of fabric before combined scouring-bleaching, (gm)	Wt. of fabric after combined scouring-bleaching, (gm)	Wt. loss of fabric	Wt. loss %
1	2	30	28.75	28.32	0.43	1.49
2	2	60	25.30	24.66	0.64	2.53
3	2	90	22.49	21.86	0.63	2.81
4	4	30	34.10	32.82	1.28	3.75
5	4	60	29.66	27.92	1.74	5.86
6	4	90	23.80	21.98	1.82	7.65
7	6	30	30	28.44	1.56	5.20
8	6	60	30	27.16	2.84	9.47
9	6	90	30	25.81	4.19	13.97

The results found here at different concentration and different time can be shown through the following bar diagram (Figure 1).

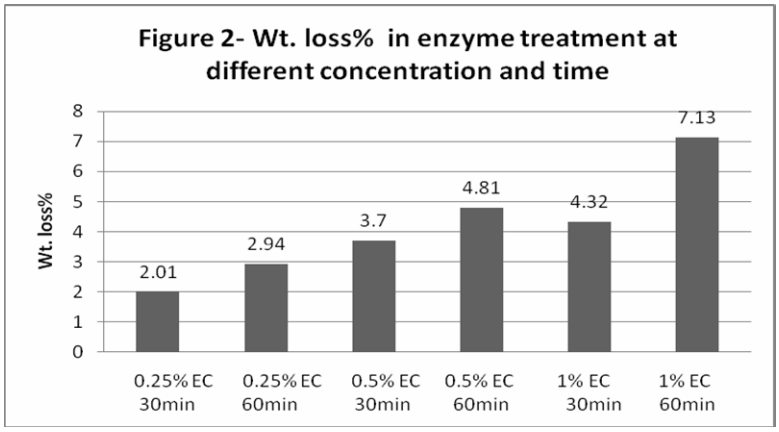


It is seen that the wt. loss increased gradually with increasing peroxide concentration over the range followed and also with increasing time of pretreatment. Bar diagram shows that the wt. loss at 2 g/l H_2O_2 for 30 min of treatment is 1.49% which is less than that at 4 g/l H_2O_2 for 30 min of treatment i. e., 3.75% and at 6 g/l H_2O_2 for 30 min of treatment i. e., 5.2%. Again, the wt. loss% is more for 90 min than 30 min and 60 min for the same concentration of H_2O_2.

Table 4. Wt. loss% of the knitted fabrics in enzymatic treatment

SI. No.	Enzyme conc. %	Time (min)	Wt. of fabric before Enzyme treatment, (gm)	Wt. of fabric after Enzyme treatment, (gm)	Wt. loss of fabric	Wt. loss %
1	0.25	30	28.32	27.75	0.57	2.01
2	0.25	60	24.66	24.08	0.58	2.94
3	0.50	30	21.86	21.05	0.81	3.70
4	0.50	60	32.82	31.25	1.57	4.81
5	1	30	27.92	26.71	1.21	4.32
6	1	60	21.98	20.42	1.56	7.13

The results found here at different concentrations and different time can be shown through the following bar diagram (Figure 2).



Here it is seen from our experiment that the wt. loss% increased proportionally with the amount of enzyme used for the same period of time and also with the time period for the same amount of enzyme. Bar diagram shows that wt. loss at 1% Biopolish EC for 30 min of treatment is 4.32% which is more than the wt. loss at 0.5% EC for 30 min i.e., 3.7% and at 0.25% EC for 30 min i.e., 2.01%. Again, at 1% EC for 60 min of treatment wt. loss% is 7.13% which is quite more than the wt. loss% occurred at .05% EC and 0.25% EC for 60 min of treatment.

CONCLUSION

Weight loss of cotton knitted fabric is directly related to the relevant process loss during the wet processing. It is an important factor for production. For higher production it is necessary to control the fabric from excessive wt. loss in knit processing. This can be achieved by following all the parameters of production accurately and by minimizing process losses. If the standard parameters are followed accurately and necessary precautions are taken for knit batch processing, fabric wt. loss can be optimized. The test results revealed that weight loss in knitted fabrics in combined scouring-bleaching and enzyme treatment was less at the lower concentration and short period of time but increased with the increasing of concentration and time. It was noticeable from the experiment that combined scouring-bleaching using 6 g/l H_2O_2 for 90 min caused wt. loss of 13.97% and bio-polishing with 1% acid cellulase for 1 hr caused wt. loss of 7.13%, which were more than the standards. That's why over scouring-bleaching or over enzyme treatment must be avoided.

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