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INFLUENCE OF BLEACH ACTIVATORS ON THE FABRIC MADE FROM COTTON (*Gossypium hirsutum* L.)

Hafiz Muhammad Asif[1], Muhammad Iftikhar[2,*] and Babar Shahbaz[2]

[1]Department of Fiber and Textile Technology, University of Agriculture, Faisalabad, Pakistan;
[2]Institute of Agricultural Extension and Rural Development, University of Agriculture, Faisalabad, Pakistan
[*]Corresponding author's e.mail: driftikharch@hotmail.com

Raw cotton contains various type of trash and most of the impurities are removed during the spinning process but still the cotton fabric coming from the weaving or knitting process always contains some impurities. Some time cotton fabric gets the oil, stains and coloured materials which affect the quality of dyed fabric. Bleaching is a process that eliminates unwanted coloured matters from the fibres, yarn and fabrics. A bleaching agent is a material that lightens or whitens a substrate through chemical action. Hydrogen peroxide is by far the most commonly used oxidative bleaching agent for cotton and its blends, accounting for more than 90 percent of all the bleaching agents. The use of activators to enhance the bleaching performance of hydrogen peroxide for cellulosic materials has gained popularity now a day. In this context the main objectives of this paper are to study the influence of different bleaching activators on cotton fabric and to give implications for textile extension. The results indicate that the activators with different concentrations, along with different concentrations of hydrogen peroxide (H_2O_2) have significant influence on the bleaching performance of cotton fabric.
Keywords: Cotton fabric, bleach activators, bleaching loss, bleaching performance and fibre

INTRODUCTION

Cotton (*Gossypium hirsutum* L.) in its natural form contain large amount of impurities including trash, dried leaves, seed particles, minerals, waxes, proteins and colouring matter, etc. In order to obtain bright substrate for dyeing or printing and to make fabric uniformly water absorbent, a pre-treatment is essential. Bleaching is an operation to remove coloured impurities from the textile fibers and fabrics. Bleach is a chemical that removes colors, improves whiteness, and disinfects (often via oxidation). Common chemical bleaches include household chlorine bleach (a solution of approximately 3–6% sodium hypochlorite), lye, oxygen bleach (which contains either hydrogen peroxide or a peroxide-releasing compound), and bleaching powder (calcium hypochlorite). Many types of bleach have strong bactericidal properties, and are used for disinfecting and sterilizing (Niaz, 2000).

It is necessary to wash out the impurities and colouring material from cotton fabric. For this purpose different processes are used e.g. singeing, desizing, scouring, mercerizing and bleaching. According to Niaz (2000) "The greyness of cotton fabrics is due to the natural pigments present in the fibres. Without bleaching it may be impossible to achieve fastness and uniformity of light shades of cotton. Bleaching is a chemical process that eliminates unwanted coloured matter from fibres, yarn and cloths. Bleaching decolourizes the coloured impurities that are not removed by scouring and prepare the cloths for further finishing process. A bleaching agent is a material that lightens or whitens a substrate through chemical action.

Cotton bleaching also involves the chemical processes that change the ability of coloured materials to absorb light by changing their degree of un-saturation. Several different types of chemicals are used as bleaching agents, and their selection depends upon the type of fibre present in the yarn. The most common bleaching agents include sodium hypochlorite, sodium chlorite, sulphur dioxide and hydrogen peroxide. Hydrogen peroxide is by far the most commonly used oxidative bleaching agent for cotton and cotton blend. The bleaching with Hydrogen peroxide is called oxidative bleaching. Although its use has the advantages of low cost, flexibility of application and the possibility of a one-bath (scour/bleach) procedure, yet hydrogen peroxide has two significant draw backs i.e. when used for hot bleaching. However, high temperature bleaching under alkaline conditions requires high energy consumption and it can cause significant fibre damage. In order to overcome these short comings researches were intensified and finally some bleach activators were developed for peroxide system incorporation (Rupon and Hooper, 1979).

The use of activators to enhance the bleaching performance of hydrogen peroxide for cellulosic materials has gained popularity. The advantage of using an activated peroxide system is that, bleaching can be achieved under milder conditions (for instance, at lower temperature, lower pH, shorter treatment duration and lower peroxide concentration), thereby minimizing the degradation of the desirable qualities of the fibre. This is particularly important

for cellulosic blends that contain delicate fibres (Ibrahim *et al.,* 2005).

Decomposition of hydrogen peroxide can be catalyzed with solid metal or metal ions in the solution. The ions used in the solution in conjunction with peroxide produce hydroxyl radicals are capable of attacking cellulose. Activated bleaching system has the potential to provide acceptable whiteness in a relatively short time by delivering more efficient bleaching through enhanced oxidation level (Maekawa *et al.,* 2007). Keeping in view the importance of bleaching in cotton processing, the main objective of the study is to create awareness among the technical as well as layman working in the textile processing departments about influence of bleach activators on the fabric made from cotton.

MATERIALS AND METHODS

The present research work was conducted at the Department of Fibre and Textile Technology, University of Agriculture Faisalabad, Pakistan in collaboration Sitara Textile Industries. Scoured samples of pure cotton fabric having weaving construction 72x60/30x30 were collected from the running stock of the mills. Padding of scoured samples with activated solution was also done. Different concentrations of activators were made in distilled water. The fabric samples were treated with different solution of activators having different concentrations as mentioned below (C_1 to C_7). The fabric samples were padded on electrical padder machine having pickup 75% in order to get uniform application of activators**.** The cotton fabric samples were then dried and put for bleaching process. The concentration and application of different bleach activators were as follow:

Activators (A)	**Activators Concentration (g/l) (C)**	**Bleaching Agents(H_2O_2) Concentrations (g/l) (B)**
A_1= $CaSO_4$	C1= 0.025	B_1= 20
	C2= 0.05	
	C3= 0.1	
A_2= $FeSO_4$	C4= 1.0	B_2= 30
	C5= 1.25	
	C6= 1.50	
A_3= $ZnSO_4$	C7= 2.0	B_3= 40

After taking all possible combinations of treatments, the following tests were carried out:

***Bleaching loss (%)*:** The bleaching loss percentage of cotton fabric was calculated by the following formula.

$$\text{Percentage of bleaching loss} = \frac{W_0 - W_1}{W_0} \times 100$$

Where W_0 = Weight of fabric before bleaching
W_1 = Weight of fabric after bleaching

***Whiteness of the fabric*:** The Instrument used for this purpose was Spectra Flash SF 600 and was calibrated by loading standard white tile. Then the samples were put one by one and readings were taken.

***Light fastness (iso105/b02*:** For this test, half side of the treated sample was covered with opaque card board and then the specimen was placed in the Spectra Light 3. The apparatus was adjusted according and after about 8 hours, the apparatus automatically stopped and the required test was completed. The sample was taken out of the apparatus. Then the sample was compared with the help of standard blue scale.

RESULTS AND DISCUSSION

***Bleaching loss (%)*:** The statistical analysis of variance and comparison of individual mean for bleaching revealed that the effect of activators (A) and hydrogen peroxide concentration (B) on bleaching loss of cotton fabric was significant and highly significant respectively. Similarly the effect of activator's concentration (C) on bleaching loss of cotton fabric was significant, while all the remaining inter actions remained non-significant. `

Duncan's multiple range tests for the comparison of individual means (Table1) showed that in case of different activators (A) the highest value of bleaching loss was 8.5% recorded at A_1 ($CaSO_4$) followed by A_2, and A_3 with values as 6.3% and 4.5%, respectively. These values had significant differences from each other. In a previous study Aamer (1998) concluded that under all the bleaching treatments, the impurities were removed. The bleaching of fabric obviously reduced the weight and consequently caused degradation of fabrics. Likewise Burkinshaw (1995) narrated that decrease in pH resulted in increased hydrolysis, when fabric was bleached under this condition, the fabric weight was reduced. He also stated that best results could be obtained at low pH value. In case of hydrogen peroxide concentrations (B), the mean values obtained for bleaching loss of cotton fabric were4.5%, 6.3% and 8.5% at B_1, B_2 and B_3, respectively.

Importance of pre-treatments has been emphasized by Bille (1987) who stated that pre-treatment ranked as a processing stage that was just as important as dyeing, printing and finishing. The pre-treatment laid the foundation for quality in textile processing. He pointed out that after reductive or oxidative treatment the impurities of cotton fabric were converted into a mobile form by dissolution, emulsification and suspension. For that purpose extractants were employed in quite different processing stages in both batch-wise and continuous process. Thus reduction in weight was calculated. Similarly Burkinshaw (1995) stated that low pH resulted in increased hydrolysis, when fabric was bleached under this condition, the fabric weight was reduced. He also stated that best results could be obtained at low pH value.

Table 1. Comparison of individual treatment means for bleaching loss % of pure cotton fabrics

ACTIVATORS		ACTIVATORS CONCENTRATIONS (g/l)		BLEACHING AGENT (H_2O_2) CONCENTRATIONS (g/l)	
	Mean (%)		Mean (%)		Mean (%)
A_1= $CaSO_4$	8.5a	C_1= 0.025	2.5	B_1= 20	4.5c
A_2= $FeSO_4$	6.3b	C_2= 0.05	3.2	B_2= 30	6.3b
A_3= $ZnSO_4$	4.5c	C_3= 0.1	3.6	B_3= 40	8.5a
		C_4= 1.0	4.0		
		C_5= 1.25	4.5		
		C_6= 1.50	6.3		
		C_7= 2.0	8.5		

(Mean values having different letters; differ significantly at 0.05% level of probability).

As regards to activator concentrations (C), the highest values for bleaching loss of cotton fabric were obtained at C_7 as 8.5% followed by C_6, C_5, C_4 C_3, C_2 and C_1, with their respective values as 6.3%, 4.5%, 4.0%, 3.6%, 3.2% and 2.5%, respectively. Ibrahim *et al.* (2005) indicated that the loss in fabric weight as well as the improvement in the degree of whiteness governed by the pretreatment method gave rise to better bleaching, fabric softness, higher retention along with greater depth of shade. Similarly the activator concentration had significant effect on the weight loss of cellulosic fabrics. Bleaching loss was found higher as the concentration of activator increased. As well as Lee *et al*. (2004) narrated that excellent results could be obtained by activated bleaching of cotton fabrics. He concluded that maximum whiteness was obtained at higher concentration of activators along with maximum weight loss of the fabric. The results are also in line with the finding of Ibrahim *et al*. (2005) that by using the activated peroxide system, bleaching can be achieved under milder conditions, thereby minimizing the degradation of the desirable qualities of the fibre.

***Cotton fabric whiteness*:** The statistical analysis of variance and the comparison of individual mean for whiteness showed that the effect of activators and bleaching concentration on whiteness of cotton fabric was highly significant. While all the interactions remained non-significant. Duncan's multiple range test for the comparison of individual means (Table 2) showed that in case of different activators (A) the highest value of whiteness was 85 Berger recorded at A_1 ($CaSO_4$) followed by A_3 ($ZnSO_4$), and A_2($FeSO_4$) with values as 77 Berger and 70 Berger respectively. These values had significant differences from each other. Bleaching made the fabric white and impurities were removed. Bleaching was necessary to increase the ability of fabric to absorb dyestuff uniformly. He further stated that the use of metal ions during bleaching process increased the whiteness of the fabric significantly along with minimum degradation of cellulosic fibres.

In case of hydrogen peroxide concentrations (B), the mean values obtained for Whiteness of cotton fabric were 85 Berger, 77 Berger and 70 Berger at B_3, B_2 and B_1, respectively. The results were supported by the research work of Gursoy and Dayioglu (2000) who concluded that hydrogen peroxide concentration has a significant effect on whiteness and water absorbency time of bleached samples. Furthermore the whiteness of the fabric was increased significantly by increasing the concentration of hydrogen peroxide. Similarly Ibrahim *et al.* (2005) indicated that the loss in fabric weight as well as the improvement in degree of whiteness was governed by the pre-treatment method, gave rise to better bleaching, fabric softness, and higher strength retention along with greater depth of shades. He obtained excellent results for whiteness at higher concentration of hydrogen peroxide as bleaching agent. Similarly Mahmood

Table 2. Comparison of individual treatment means for whiteness of pure cotton fabrics

ACTIVATORS		ACTIVATORS CONCENTRATIONS (g/l)		BLEACHING AGENT (H_2O_2) CONCENTRATIONS (g/l)	
	Mean (%)		Mean (%)		Mean (%)
A_1= $CaSO_4$	85a	C_1= 0.025	60e	B_1= 20	70c
A_2= $FeSO_4$	77c	C_2= 0.05	62d	B_2= 30	77b
A_3= $ZnSO_4$	70 b	C_3= 0.1	64cd	B_3= 40	85a
		C_4= 1.0	64c		
		C_5= 1.25	70bc		
		C_6= 1.50	77b		
		C_7= 2.0	85a		

(Mean values having different letters; differ significantly at 0.05% level of probability).

(2004) narrated that greater whiteness could be achieved by using hydrogen peroxide bleaching than other bleaching agents. He noted that maximum degree of whiteness was achieved at the higher level of hydrogen peroxide concentration.

As regarded to activator concentrations (C), the highest values for whiteness of cotton fabric were obtained at C_7 as 85 Berger, followed by C_6, C_5, C_4 C_3, C_2 and C_1 with their respective values as 77 berger, 70 berger, 64 berger, 64 berger, 62 berger and 60 berger, respectively. The result showed that whiteness of cotton fabric increased up to certain limit by increasing concentration of activators. The present research indicated that as the activator concentration decreased from the optimum value, whiteness was decreased. Diller *et al*. (1998) found that heavy metal ions such as Ferrous (Fe) and Cupper (Cu) drastically increased the peroxide activation and the bleaching rate by catalyzing the decomposition of hydrogen peroxide. He further stated that acceptable degree of whiteness was achieved in the presence of such metal ions, with only a little fibre damage. Similarly Jackie and Evans (2007) narrated that the use of activators enhanced the bleaching performance of hydrogen peroxide for cellulosic materials. They used activators during bleaching process and found that whiteness of the fabric was improved significantly when treated with different concentration levels of activators.

***Light fastness of cotton fabrics*:** Colour fastness to light measured the resistant to fading of dyed textiles when exposed to day light. The visual results obtained by blue scale of fabric fastness against light after applying different bleach activators (A), activator concentrations (C) and different bleaching agent concentrations (B), on pure cotton fabric samples presented in Table 3. The results showed that fabric fastness against light was dependent on different bleach activators (A), activator concentrations (C) and different bleaching agent concentrations (B).The results indicated that overall performance of A1 was excellent (8) for fabric light fastness according to blue scale rating .The blue scale rating for A2 was recorded good (4-5) and for A3 was good to very good (6-7) as shown in Table 3a & Table 3b. The results were supported by the research work of De-Giorgi and Cernani (1985) stated that reactive dyes have excellent fastness values for washing, perspiration and light tests as well as Tanveer (1999) reported that cotton fabric dyed with reactive dyes found very good to excellent performance against light. Also Narani (2005) worked on the reactive dyes and their fastness properties and confirmed that reactive dyes have very good light fastness. The results were supported by the research work of Shike and Lee (1987) reported that the nature of dye-substrate bond affected the light fastness. The stronger the dye-substrate bond, the more it would be stable to light, resulted in higher light fastness of covalent bonded molecules. The results indicated that overall performance of B1 was good to very good (6-7) for fabric light fastness

Table 3. Light fastness of dyed samples

Dye	Activator	Bleaching concentration	Activator concentration	Light fastness
D	A_1	B_1	C_1	6-7
			C_2	6-7
			C_3	6-7
			C_4	6-7
			C_5	6-7
			C_6	6-7
			C_7	6-7
		B_2	C_1	6-7
			C_2	6-7
			C_3	6-7
			C_4	6-7
			C_5	6-7
			C_6	6-7
			C_7	6-7
		B_3	C_1	6-7
			C_2	7
			C_3	7
			C_4	8
			C_5	8
			C_6	8
			C_7	8

Excellent = 8, Very good= 6-7, Good = 4-5, Moderate = 3, Poor= 2, Very Poor=1

Table 3a. Light fastness of dyed samples

Dye	Activator	Bleaching concentration	Activator concentration	Light fastness
D	A_2	B_1	C_1	4-5
			C_2	4-5
			C_3	4-5
			C_4	4-5
			C_5	4-5
			C_6	4-5
			C_7	4-5
		B_2	C_1	5-6
			C_2	6-7
			C_3	6-7
			C_4	6-7
			C_5	6-7
			C_6	6-7
			C_7	6-7
		B_3	C_1	6-7
			C_2	6-7
			C_3	6-7
			C_4	6-7
			C_5	6-7
			C_6	6-7
			C_7	6-7

Excellent = 8, Very good= 6-7, Good = 4-5, Moderate = 3, Poor= 2, Very Poor=1

Table 3b. Light fastness of dyed samples

Dye	Activator	Bleaching concentration	Activator concentration	Light fastness
			C_1	5-6
			C_2	5-6
			C_3	5-6
		B_1	C_4	5-6
			C_5	6-7
			C_6	6-7
			C_7	6-7
			C_1	5-6
			C_2	5-6
			C_3	5-6
D	A_3	B_2	C_4	6-7
			C_5	6-7
			C_6	6-7
			C_7	6-7
			C_1	6-7
			C_2	6-7
			C_3	8
		B_3	C_4	8
			C_5	8
			C_6	8
			C_7	8

Excellent = 8, Very good= 6-7, Good = 4-5, Moderate = 3, Poor= 2, Very Poor=1

according to blue scale rating .The blue scale rating for B2 was recorded very good to excellent (7) and for B3 was excellent (8). The results were supported by the research work of Bernard (1983) described the fastness properties of reactive dyes. Light fastness was very good on most of the fibres.

***Conclusions*:** The activators with different concentrations, along with different concentrations of hydrogen peroxide (H_2O_2) influenced the bleaching performance of cotton fabric. Excellent results relating to fabric whiteness were obtained for the bleach activators $A_1(CaSO_4)$and $A_3(ZnSO_4$)at maximum level of hydrogen peroxide i.e. B_2 and B_3 along with acidic range of pH factor. Bleaching loss was increased with the increase of hydrogen peroxide (H_2O_2) level and minimum pH range along with maximum degree of whiteness of cotton fabric.

The textile industries are generally agro-based so that the extension services regarding different textile technologies and research should be taken at the door step of the industrialists and the technical manpower for further improvement in the capacity building of the staff working in the bleaching industries. It is suggested that the present work may be extended by using other different bleach activators suitable for cotton fabric to increase the bleaching performance at optimum stages. The extension services being provided by the Ministry of Textile in the form of different international aspects should also be extended in the line of research and development to enhance the fabric bleaching quality to meet the international standards and for income generation to reduce the poverty ratio in the country.

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