

Effect of different bleaching agents on various knit fabrics

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Abstract— Bleaching agents play a vital role to remove the natural color and induce absorbency to the cellulosic cotton fibre. In this research work different bleaching agents are used like- Hydrogen per oxide (H_2O_2), Sodium hypo chlorite ($NaClO$), Sodium Chlorate ($NaOCl_2$) and Sodium bisulphate ($NaHSO_3$) on Single jersey, Rib and Pique fabric to investigate effect on Whiteness Index, color difference and at last cost also considered. To the end better outcome is observed for Hydrogen per oxide (H_2O_2).

Keywords—Cellulose, Bleaching, Whiteness, Absorbency and Cost.

1 INTRODUCTION

Cellulose especially cotton is the ancient and the most important of the textile fibers. It has natural colors like yellowish to brownish which hampered the coloration. So for getting discoloration bleaching is essential. In pretreatment process bleaching agents either oxidize or reduce the coloring matter which is washed out and whiteness thus obtained is permanent nature [1]. It carried on imparting whiteness as absorbency to cellulose by removing natural color which is inherited by origin. For this research many bleaching agents are induced i.e. Hydrogen per oxide (H_2O_2), Sodium hypo chlorite ($NaClO$), Sodium Chlorate ($NaOCl_2$), Sodium bisulphate ($NaHSO_3$). The motto of this research was to investigate the comparison of different bleaching agents on whiteness, color difference and costing.

2 EXPERIMENTAL

2.1 Raw materials

100% cotton Single jersey, Rib, Pique fabric was used in this experiment. The fabrics were supplied by KEYA KNIT COMPOSIT LTD., Gazipur, Bangladesh.

2.2 Chemicals and colorants

Hydrogen per oxide (H_2O_2), Sodium hypo chlorite ($NaClO$), Sodium Chlorate ($NaOCl_2$), Sodium bi sulphate ($NaHSO_3$) and Potassium permanganate ($KMnO_4$), Sequestering agent, Wetting agent, Caustic soda, Acetic acid, Enzyme, Glouber salt were supplied by that factory.

The dyes i.e. Remazol Yellow 3R, Remazol Red R2G, Remazol Blue 3R were supplied by the factory.

2.3 Equipment

Laboratory scale knit fabric exhaust dyeing machine DATACOLOR AHIBA IR Pro were used for pre-treatment and dyeing of fabric. Spectrophotometer DATACOLOR 650 was used for measuring whiteness index of bleached fabric and also K/S value of dyed fabric.

2.4 Recipe of processing

The gray fabrics are pre-treated and dyed according to the following recipe which was presented in Tables 1 and 2.

2.5 Methods

2.5.1 Bleaching

The fabric was pretreated with the liquor ratio of 1:8 using for bleaching. The pre-treatment started at 40°C in the presence of 1 g/L sequestering agent, 1 g/L wetting agent and 0.5 g/L leveling agent. The bath was circulated for 10 min, after which 4.6 g/L caustic soda and 0.3 g/L peroxide stabilizer were added. After a further 30 min circulation, 2 g/L bleaching agent was added, then the bath temperature was raised to 100° C at a gradient 2° C/min and maintained for 45 min. The enzymatic pre-treatment and bleaching started at 40° C with an addition of 0.46 g/L of enzymes containing pectinases. The bath was then heated to 80 ° C at a gradient 3° C/min for 10 min. At 70° C a cold wash is done for 10 min. Both pre-treatment procedures were completed with neutralization by 0.8 g/L acetic acid and rinse.

Process Chemicals	Amount
Sequestering agent	1 g/L
Wetting agent	1 g/L
Leveling agent	0.5 g/L
Caustic soda	4.6 g/L
Stabilizer	0.3 g/L
Bleaching agent	2 g/L
Enzyme	0.46 g/L
Acetic acid	0.8 g/L

Table 1: Bleaching Recipe

2.5.2 Dyeing

The bleached samples were subsequently dyed with Remazol Yellow 3R (1%), Remazol Red R2G (0.48%) and Remazol Blue 3R (0.02%) in the DATACOLOR AHIBA IR laboratory apparatus at a liquor ratio of 1:8. The initial dyeing temperature was 30 °C and the dyebath consisted of 1 g/L sequestering agent, 1 g/L of a leveling agent and electrolyte (40 g/l Glauber Salt). Within 20 mins the dyebath was heated to 65 °C. Then the dyebath was further running for 20 mins. Afterwards add to the dye bath of 15 g/l of sodium carbonate (Na₂ CO₃) to maintain pH 10.5 and finally run for the 45 min. After completion of run time rinsing the sample with cold and hot water, as well as neutralization with acetic acid and soaping with 1 g/l of a soaping agent. Then the dyed sample was dried at 75°C and the pretreated and dyed samples of the cotton knitted fabric were colorimetrically evaluated using a spectrophotometer (Datacolor-650). The CIE equation was used to calculate the whiteness of the scoured and bleached samples, the CIELAB color values (lightness L*, red/green axis a*, yellow/blue axis b*, chroma C*, and hue h), and the CIELAB color differences (ΔE*) were determined for the dyed samples.

Process Chemicals	Amount
Sequestering agent	1 g/L
Wetting agent	1 g/L
Leveling agent	1 g/L
Caustic soda	4.6 g/L
Remazol Yellow 3R	1 %
Remazol Red R2G	0.48 %
Remazol Blue 3R	0.02 %
Glauber Salt	40 g/L

Sodium carbonate	15 g/L
Soaping agent	1 g/L
Acetic acid	1 g/L

Table 2: Dyeing Recipe

2.5.3 Whiteness Index

The whiteness of each pretreated and chemically bleached sample was evaluated on the basis of the following CIE equation for illuminant D65 and 1964 10° observer Equation

$$W = Y + 800(X_n - X) + 1700(Y_n - Y)$$

Where Y is the tristimulus value of the sample; X and Y are the chromaticity coordinates of the sample, X_n and Y_n are the chromaticity coordinates for the perfect reflecting diffuser (0.3138 and 0.3310, respectively).

Whiteness of fabric analyzed under spectrophotometer and weight loss were analyzed by taking weights of substrate before and after the bleaching process [2]. The CIE Whiteness Index value (CIE WI) was determined for the bleached fabric using AATCC test method. The whiteness was measured using a DATACOLOR 650, illuminants D-65 [3].

3 Results and Discussion

3.1 Effect of bleaching agents on whiteness of fabrics

Whiteness Index				
Fabric type	H ₂ O ₂	NaHSO ₃	NaClO ₂	NaOCl
Single jersey	73.29	38.49	63.71	50.73
Pique	76.71	33.87	55.47	51.53
Rib	77.51	46.09	53.64	45.79
Interlock	80.32	41.47	60.69	48.26

Table 3: Whiteness Index

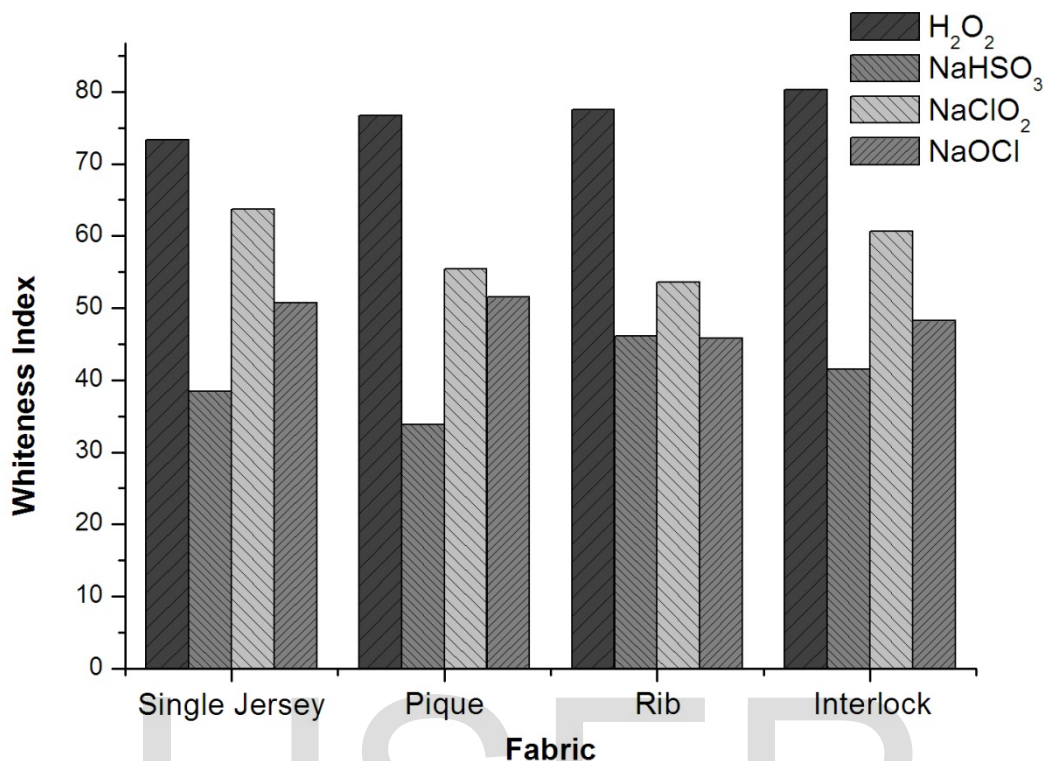


Figure 1: Bleaching effect on fabric for whiteness index

From the figure (fig. 1) it is observed that Hydrogen peroxide (H₂O₂) gives best whiteness compare to others. And the second position belongs to Sodium chlorate (NaOCl₂), the lowest whiteness reveals on Sodium bisulphate (NaHSO₃). Hydrogen peroxide is a powerful oxidizing agent that rapidly destroys the natural coloring matters present in cotton without undue oxidative damage to the fibers [4, 5]. It is studied that whiteness index for balance fabric (Rib, Interlock) is slightly more than imbalance fabric (Single jersey, Pique).

3.2 Effect of bleaching agents on color difference of fabrics

CIELAB color difference

Fabric type	H ₂ O ₂	NaHSO ₃	NaClO ₂	NaOCl
Single jersey	0.85	1.28	0.97	1.69
Pique	1.06	1.3	1.1	1.87
Rib	1.01	1.1	1.79	0.82
Interlock	0.64	0.82	1.42	1.31

Table 4: CIELAB color difference

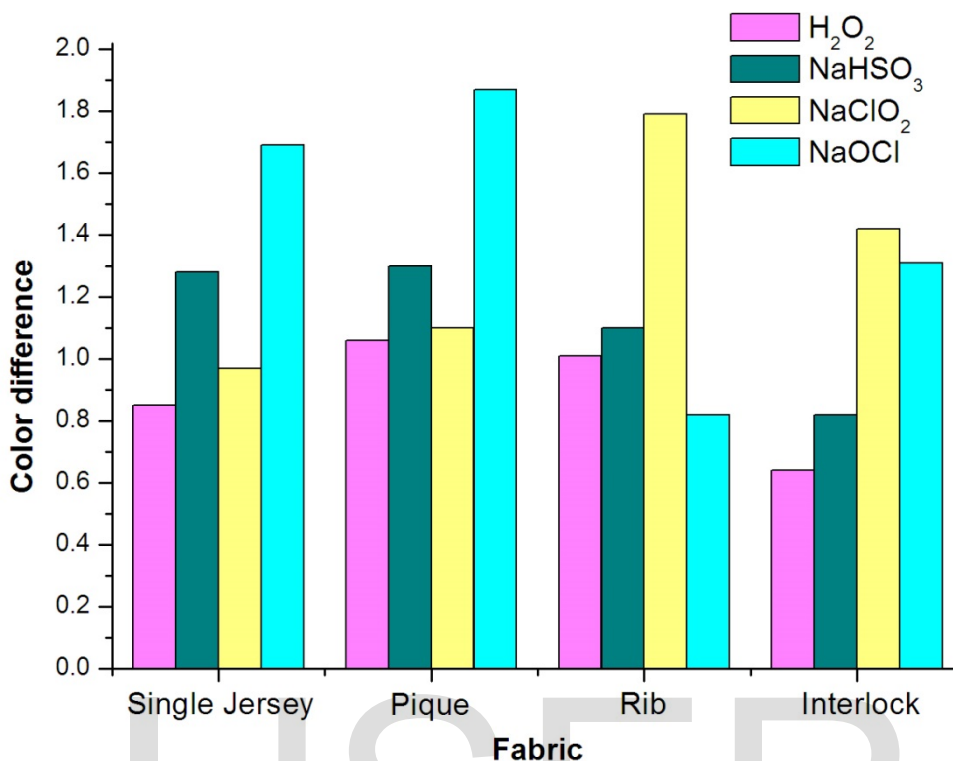


Figure 2: Bleaching effect on fabric for color difference

It is found from the figure (fig.2) that there is minimum color difference in case of Hyhrogen peroxide (H₂O₂) on all types of fabrics. On the other hand Sodium hypochlorite (NaOCl) shows large color difference on almost all the fabrics. It is observed that for balance fabric (Rib, Interlock) color difference is lesser than imbalance fabric (Single jersey, Pique).

3.3 Cost comparison

Reagent	Cost(\$/kg)
H ₂ O ₂	0.47
NaHSO ₃	0.80
NaClO ₂	0.49
NaOCl	0.86

Table 5: Cost comparison

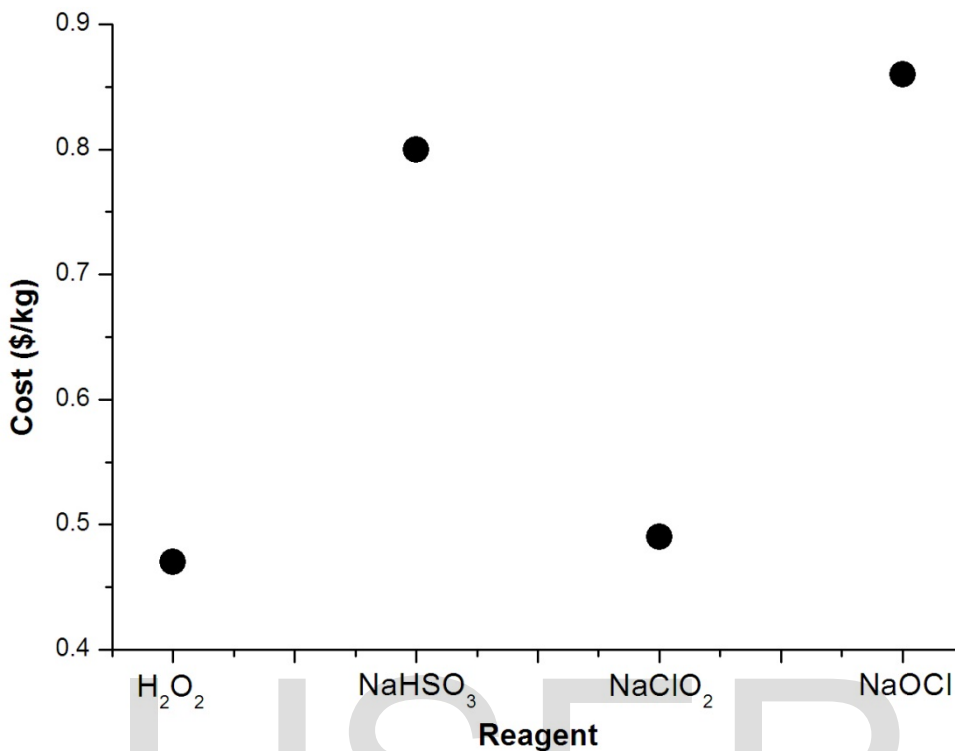


Figure 3: Cost comparison among different bleaching agents

Considering cost to purchase the lowest price (0.47\$/kg) goes to Hydrogen peroxide (H_2O_2) and highest to Sodium hypochlorite (0.86\$/kg) which are collected from local market with the figure 3.

4 Conclusion

There are several numbers of bleaching agents that are taken to the research work. According to results and discussions, the effectivity of whiteness and CMC color difference value is best in case of H_2O_2 to other bleaching agents. The market price is also minimum compare to others. That's why Hydrogen peroxide (H_2O_2) bleaching agent is best for bleaching process for cotton fabric.

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