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Effects of a Multi Scouring Agent on the Pretreatment and Dyeing of different Cellulosic Knitted Fabrics

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Abstract
The study tested the use of Viscobleach as a multi-scouring agent for pretreating cellulosic fabrics (cotton, viscose, and linen) instead of using traditional agents (caustic soda, soda ash, and hydrogen peroxide). The results showed an increase in whiteness and absorbency for viscose and linen fabrics pretreated with Viscobleach. The color strength (K/S) increased for all shades of cotton and for medium and dark shades of viscose and linen. The study also showed that the dye pick-up was higher and dye wastage lower with the Viscobleach pretreatment. The color fastness to wash and rubbing was rated 4-5 for all samples.

Keywords
multiscouring agent, reactive dye, viscobleach, fastness, Scouring.

1. Introduction

The presence of non-cellulosic compounds such as proteins, pectins, oils, waxes, inorganic materials in the cuticle and primary cell wall of cellulosic fiber make the fiber hydrophobic and non-water-absorbent during subsequent processes [1,2]. For that, combined scouring and bleaching is done at present, where scouring is done for removing hydrophobic substances and bleaching to eliminate yellowish natural coloring matter from cellulosic fibers with hot aqueous solution of NaOH and hydrogen peroxide at high temperature (95-100ºC) and high pH [3–5].

For maintaining high temperature, a lot of energy is needed and more time required, which reduces production efficiency [6]. Both high temperature and high pH lead to the degradation of fiber and decomposition of peroxide, which leads to the use of stabilizers [7]. After bleaching and before dyeing, a large amount of water is required for washing the residual un-decomposed hydrogen peroxide and alkali [8,9]. To encounter the negative impact of NaOH and hydrogen peroxide and minimize the chemicals used in pretreatment, this experiment is done [10–13].

Recently, environment-friendly alternatives are being introduced in different textile treatment to ensure that there are energy savings, less water usage, less chemical usage and overall finding of eco-friendly solutions [14–16].To support that, multi scouring agents are being studied by researchers [17–19].

The present effort of our study is to use multi scouring agents such as Viscobleach in the pretreatment of cotton, linen and viscose, which eliminates the usage of caustic soda for cotton fabric scouring and hydrogen peroxide for bleaching, as well as the usage of soda ash for viscose and linen fabric scouring. The multi scouring agent is a chemical product that has a strong anionic charge in the molecule which can modify the pretreatment characteristics of cellulosic fibers. Viscobleach contains an activator, stabilizer complexing agent and mild alkali. It eliminates the usage of caustic soda for cotton fabric scouring and hydrogen peroxide for bleaching, as well as the usage of soda ash for viscose and linen fabric scouring. The temperature can be reduced up to 18 °C for cotton pretreatment and 10 °C for viscose and linen pretreatment. Multi scouring agents do not require higher pH to function properly; pH 9.5-10 is enough for it to remove the impurities from cellulosic fabric. There is less energy usage due to the requirement of lower temperature.

For our present work, the reactive dyes used were Avitera reactive dyes, which are poly-reactive dyes that ensure rapid and very high exhaustion for cotton and other cellulosic fibers. These new dyes significantly reduce water and energy consumption and carbon dioxide (CO_2) emissions during the dyeing and washing-off process. The dyes deliver the highest level of wet-fastness across the entire shade gamut and color spectrum[20].

Researchers have proven that caustic soda, soda ash, scouring agent, and H_2O_2-bleach stabilizer can all be successfully replaced by a multi-functional scouring agent (M.F.S.A.) [21]. It possesses potent cleaning, dispersing, emulsifying, and chelating qualities that make it particularly useful in bleach baths [22,23].The two procedures in this experiment: scouring, and bleaching were carried out in one step. It reduces the amount of chemicals needed for the entire pretreatment procedure; in this case, only two chemicals were employed. For the treatment of water and washing of treated fabric, no further chemicals are necessary. Afterwards, simply a cold wash was performed.

This paper analysed the effects of Viscobleach as a multiscouring agent used in the pretreatment of cellulosic (cotton, linen, viscose) knitted fabric by testing absorbency, whiteness and dyeing characteristics with different shade percentages of dyes.

2. Materials and Methods

2.1. Materials

100% Cotton knitted fabric of GSM 160, 100% Linen knitted fabric of GSM 160 and 100% Viscose knitted fabric of GSM 160 were procured from Fariha Knit Tex Ltd, Dhaka, Bangladesh

A multiscouring agent (Viscobleach-Anionic, pH: 9.5-10, Eksoy chemicals), caustic soda (FKTL), soda ash (Nirma Ltd.), hydrogen peroxide (H_2O_2)(FKTL), peroxide killer (Aux & Hue), peroxide stabilizer (Aux & Hue), Avitera reactive dye (Huntsman Singapore Pte Ltd.), and glauber salt (RS Trading) were used in the experiment, obtained from Fariha Knit Tex Ltd.

2.2. Methods

2.2.1. Pretreatment

Two types of pretreatments were conducted in this experiment. Conventional pretreatment included regular industrial methods, whereas the experimental pretreatment involved the replacement of caustic soda, soda ash light, abd H_2O_2, H_2O_2 stabilizer with Viscobleach. The procedure followed in each type of pretreatment is given below:

Sample ID	Sample description	Pretreatment chemicals and parameters	Pretreatment bath auxiliaries
CCP	Cotton conventionally pretreated sample	Caustic soda:1.5 g/L H_2O_2: 2 g/L H_2O_2 stabilizer: 0.25 g/L pH: 11 Time: 60 min Temp: 98 °C	Wetting Agent: 1 g/L Sequestering agent: 1 g/L Anti creasing agent: 0.8 g/L
VCP	Viscose conventionally pretreated sample	Soda ash light: 1.5 g/L pH: 10.5 Time: 20 min Temp: 90 °C	
LCP	Linen conventionally pretreated sample		
CEP	Cotton experimentally pretreated sample	Viscobleach: 2 g/L pH: 9.5 Time: 60 min Temp: 80 °C	
VEP	Viscose experimentally pretreated sample		
LEP	Linen experimentally pretreated sample		

Table 1. Pretreatment recipe for cotton, viscose, and linen

From Table 1, it can be seen that for all pretreatment methods, the bath was set maintaining a 1:6 ratio with the required fabric at 60 °C, with a wetting agent (1 g/l), sequestering agent (1 g/l), and anticreasing agent (0.8 g/L).

For the cotton conventionally pretreated sample, caustic soda (1.5 g/l) was added at 60 °C with the auxiliaries, and the temperature was raised to 70°C. Then H_2O_2 (2 g/l) and H_2O_2 stabilizer (0.25 g/L) was added, and left for 5 minutes. The temperature was raised to 98 °C with 1.5 °C gradient and left for 60 minutes at pH 11; the bath was then cooled down to 60 °C and drained. Then one room temperature wash and one cold wash at 40 °C were done separately.

For viscose and linen conventionally pretreated sample (VCP and LCP), soda ash light (1.5 g/l) was added at 60 °C with the auxiliaries and raised temperature to 90 °C run for 20 minutes at pH 10.5, the bath was then cooled down to 60 °C and drained. Then one room temperature wash and one cold wash at 40 °C was done separately.

For the experimentally pretreated cotton, Viscose and Linen samples (CEP, VEP, LEP), a multiscouring agent (Viscobleach) (2 g/l) was added at 60 °C with the auxiliaries, the temperature raised to 80 °C, then they were left for 60 minutes at pH 9.5, the bath next cooled down to 60 °C and drained. Then one room temperature wash and one cold wash at 40 °C were done separately.

2.2.2. Dyeing

All the conventionally and experimentally pretreated samples were dyed at shades of 0.5 %, 1.5 % and 3 % according to the following recipe using a sample dyeing machine (Fong's-China).

The dyeing bath was set maintaining an M:L ratio of 1:6 with the required fabric at 60 °C with a wetting agent (1 g/l) (Felosan NOF- Cht smart Chemistry / RH corporation), sequestering agent (1 g/l) (Lufibrol 2UD- Archroma Singapore Pte Ltd), anticreasing agent (0.8 g/L) (Ceranine WN SR- Archroma Singapore Pte Ltd), levelling agent (3 g/l) (sarabid MIP- cht Bezema/RH Corporation), acetic acid (1 g/l) (Narayanganj Dyes and Chem), and reactive dye (0.5 %, 1.5 % and 3 %) for light, medium and dark shades correspondingly. After that, 30 g/l salt, 35 g/l salt and 50 g/l salt were added for light, medium and dark shades, correspondingly. Then the temperature was raised to 80 °C for 10 minutes for migration and then lowered to 60 °C. After doing so, for the light shade 15 g/l of soda, for the medium shade 15 g/l of soda, and for the dark shade 20 g/l of soda were added and then left for 60 minutes. After which time, the bath was drained. Then, one room temperature wash and one hot at 80 °C were done.

Pretreated dyeing sample ID	Sample description	Conc. of dye	Dyeing bath chemicals	Dyeing bath auxiliaries and parameters
CCP_L	Cotton conventionally pretreated cotton dyeing sample for light shade	0.5 %	Salt: 30 g/L Soda: 15 g/L	Wetting agent: 1 g/L Sequestering agent: 1 g/L Levelling agent: 3 g/L Anti-creasing agent: 0.8 g/L Temperature: 60 °C Time: 60 min pH: 10-11
CEP_L	Cotton experimentally pretreated cotton dyeing sample for light shade			
VCP_L	Viscose conventionally pretreated dyeing sample for light Shade			
VEP_L	Viscose experimentally pretreated dyeing sample for light shade			
LCP_L	Linen conventionally pretreated dyeing sample for light shade			
LEP_L	Linen experimentally pretreated linen dyeing sample for light shade			
CCP_M	Cotton conventionally pretreated dyeing sample for medium shade	1.5 %	Salt: 35 g/L Soda: 15 g/L	
CEP_M	Cotton experimentally pretreated cotton Dyeing sample for medium shade			
VCP_M	Viscose conventionally pretreated dyeing sample for medium shade			
VEP_M	Viscose experimentally pretreated dyeing sample for medium shade			
LCP_M	Linen conventionally pretreated dyeing sample for medium shade			
LEP_M	Linen experimentally pretreated dyeing sample for medium shade			
CCP_D	Cotton conventionally pretreated dyeing sample for dark shade	3 %	Salt: 50 g/L Soda: 20 g/L	
CEP_D	Cotton experimentally pretreated dyeing sample for dark shade			
VCP_D	Viscose conventionally pretreated dyeing sample for dark shade			
VEP_D	Viscose experimentally pretreated dyeing sample for dark shade			
LCP_D	Conventionally pretreated linen dyeing sample for dark shade			
LEP_D	Linen experimentally pretreated dyeing sample for dark shade			

Table 2. Dyeing recipe for cotton, viscose, and linen

Here, 3 types of dyed samples according to shade %, as shown in Table 2, were prepared from the CCP sample, which were CCP_L, CCP_M, and CCP_D. Accordingly, from the CEP sample, CEP_L, CEP_M, and CEP_D samples were prepared.

From the VCP sample, VCP_L, VCP_M, and VCP_D samples were prepared (Table 2). From the VEP sample, VEP_L, VEP_M, and VEP_D samples were prepared. From the LCP sample, LCP_L, LCP_M, and LCP_D samples were prepared (Table 2). From the LEP sample, LEP_L, LEP_M, and LEP_D samples were prepared.

2.2.3. Neutralization

After that neutralization was done with acetic acid (1 g/l) and a sequestering agent (1 g/l) at 40 °C, the temperature raised to 55 °C, and it was left for 20 minutes. One cold wash was done at 40 °C for 10 minutes in a sample dyeing machine (Fong's - China).

2.2.4. After treatment

After neutralization, soaping was done at 95 °C for 20 minutes for all the dyed samples. Then it was followed by a hot wash at 80 °C for 10 minutes. After which, a rinse wash and two cold washes were done at 40 °C for 10 minutes. After the cold wash, softening treatment was done on the fabric at 55 °C for 20 minutes, and then it was unloaded. Afterwards, treatment was carried out in a sample dyeing machine (Fong's-China).

2.3. Characterization

2.3.1. Data color analysis

2.3.1.1 Whiteness index

The whiteness index was checked using a Data color Spectro 1050, USA at Fariha Knit Tex Ltd.; the test was done by means of a spectrophotometer using a D65 illuminant at 10 degrees.

2.3.1.2 Color strength

A Data color 650 spectrophotometer was used for assessment of the color strength of the dyed fabric at Fariha Knit Tex Ltd.

2.3.2. Absorbency

Fabric absorbency was checked using Direct Congo Red (Huntsman Singapore Pte Ltd) after scouring at the Wet Processing Lab, Bangladesh University of Textiles. Afterwards, AATCC 79. 0.1 % solution of Direct Congo Red was prepared with distilled water. Then the solution was dropped on different places of the fabric sample using a dropper at room temperature. After that, the absorption of the colored drop was observed carefully. Then the absorption time was noted by noticing the spread and different shapes of the drop, and they were compared to the standard shape.

2.3.3. Rubbing fastness

Rubbing fastness (Dry and Wet) was measured using the ISO 105 X12 standard to determine the color fastness of the textile against abrasion.

2.3.4. Color fastness to washing

The resistance capability of the color of the dyed fabric against washing is known as colorfastness to washing. The ISO 105 C06 B_2S method was used for the testing.

3. Results and discussion

3.1. Pretreatment of fabric

3.1.1. Whiteness index

In this test, as shown in Figure 1, the whiteness index is higher for conventionally pretreated cotton sample (CCP) than for the experimented one (CEP) (the sample identification of pretreated samples is shown in Table 1). This may be because NaOH is known for its ability to remove various impurities from cotton, whereas mild alkali present in the multiscouring agent was too mild to eliminate all the natural waxes, oils, pectins and other impurities. The whiteness index of the viscose sample was more increased for the experimental sample (VEP) than for the conventionally pretreated sample (VCP). This maybe

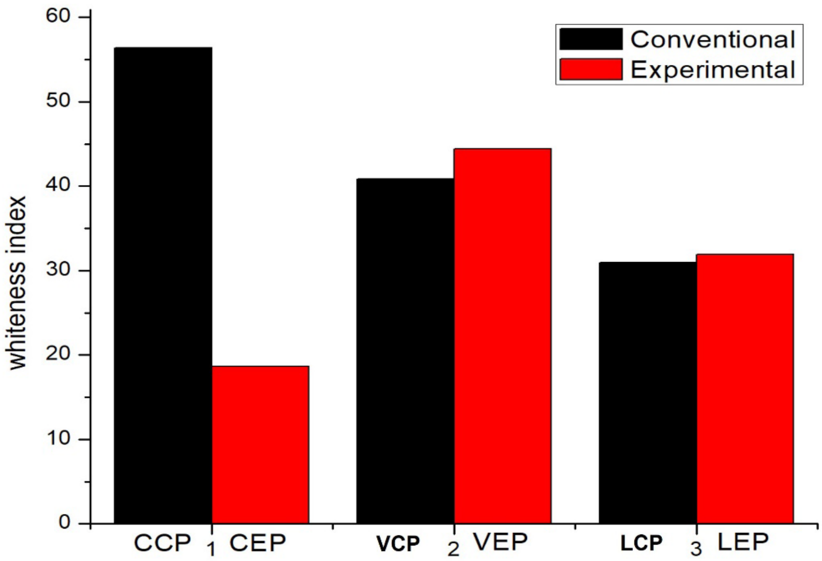

Fig. 1. Whiteness index of pretreated samples

because soda ash only removes natural impurities, while Viscobleach targets a wide range of impurities. For example, sulfur content is eliminated when applied to viscose pretreatment. Thus, this could be the reason for the better whiteness index of the multiscouring agent treated fabric [1]. Also, it can be seen in Figure 1, that the whiteness index value slightly increased for linen with multiscouring treatment, which could be attributed to the fact that it eliminates a wide range of impurities, as compared to soda ash [4].

3.1.2. Absorbency

The absorbency of pretreated samples CCP, CEP, VCP, VEP, LCP and LEP is shown in Table 3. From Figure 2 it is observed that the absorbency of the cotton experimentally pretreated sample (CEP) was quite poor as it took much time to absorb, and the shape was uneven, as compared with the conventionally pretreated sample (CCP). The decreased absorbency of cotton with multiscouring agents compared to sodium hydroxide may be due to the presence of mild alkali in the multiscouring agent, which is unable to effectively remove that full range of waxes and impurities, hindering the cotton's ability to properly absorb liquids [4,5]. But the viscose and linen showed a good result in the case of both conventional samples (VCP, LCP) and experimental samples (VEP, LEP).

3.2. Dyeing of fabric

3.2.1. Color strength

Color strength (K/S) is the most important parameter to test the quality of a sample in terms of the depth of the color-dyed fabric. A comparison of the K/S value between the conventional and experimental methods is presented here. It was observed that the peak value at 520 nm was almost similar for all of the samples.

The result of the color strength of all dyed fabric samples is shown in Figure 3., from which it is observed that the K/S value increased more for the experimental cotton sample (CEP_L, CEP_M, CEP_D) than for the conventional sample (CCP_L, CCP_M, CCP_D). The high K/S value observed in cotton can be attributed to the fact that the multiscouring agent (Viscobleach) may have modified the surface characteristics of the fabrics, which improved dye diffusion, retention and binding capability, resulting in enhanced color intensity.

In some cases, like for medium and dark shades of viscose and linen, the K/S value increased. . This could be attributed to the fact that multiscouring agents are specially formulated to target a wide range of impurities, both natural and synthetic. They prove to be particularly

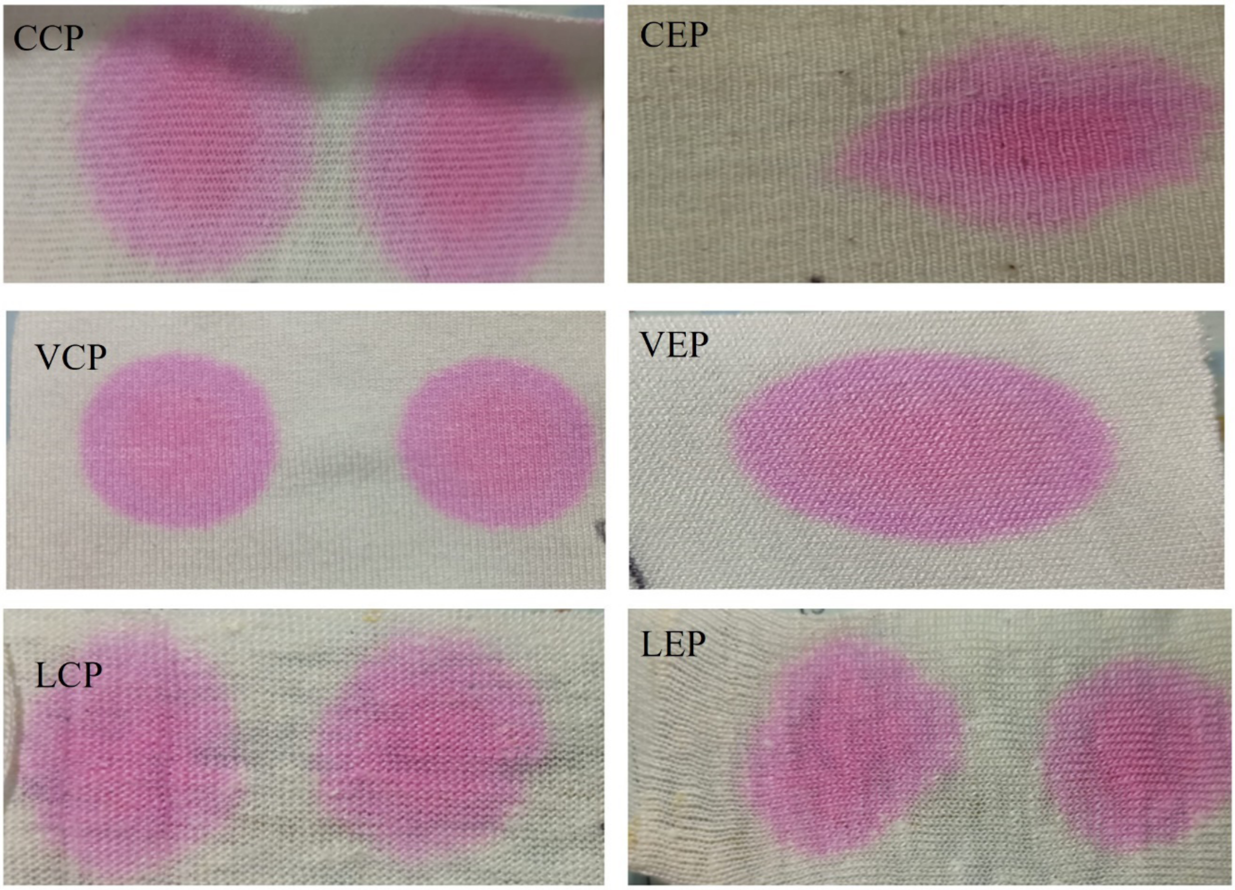

Fig. 2. Results of the drop test sample

Sample ID	Time	Comment
CCP	1 sec	Good
CEP	5 sec	Uneven shape (Not good)
VCP	1 sec	Good
VEP	1 sec	Good
LCP	3 sec	Good
LEP	3 sec	Good

Table 3. Absorbency test results of pretreated samples

effective for viscose since Viscobleach removed sulfur from it, which might result in stronger surface binding of the reactive dye to the surface of the fabric.

3.2.2. Rubbing fastness

The rubbing fastness results of all the dyed samples are shown in Table 4. From which, it can be seen that for cotton, the experimental samples (CEP_L, CEP_M, CEP_D) showed better rubbing fastness (wet and dry) than the conventional method sample (CCP_L, CCP_M, CCP_D). The increase in rubbing fastness in the cotton sample can be attributed to the fact that the multiscouring agent is formulated to provide a milder treatment while still achieving effective cleaning with traditional scouring, high pH and aggressive action, which can potentially damage cotton fibers during scouring and reduce rubbing fastness [13].

From Table 4, it is observed that for viscose, the conventional method samples (VCP_M, VCP_D) showed better rubbing fastness (wet) for medium and dark shades. Rubbing fastness (dry) was the same for all samples.

It is observed that for the linen sample, the rubbing fastness (dry and wet) result was the same, **4 - 5** for both the conventional method samples (LCP_L, LCP_M, LCP_D) and experimental samples (LEP_L, LEP_M, LEP_D).

3.2.3. Wash Fastness

In Table 5 results of the wash fastness of the dyed samples (staining and fading) are shown. And the test results are shown in Figure 4. From Table 5 for the cotton samples, the wash fastness result was the same for both the experimental (CEP_L, CEP_M, CEP_D) and conventional method samples (CCP_L, CCP_M, CCP_D).Even the result was better for the medium and dark shade samples of the experimental method. This better performance in wash fastness can be attributed to the fact that Viscobleach uses lower temperature and mild alkali, which does not weaken cellulosic fabric and results in better wash fastness [13,14]. Even the result was better for medium and dark shade samples of the experimental method. The wash fastness rating was almost good to excellent for all samples.

Sample ID	Rubbing fastness	
	Dry	Wet
CCP_L	4/5	4
CEP_L	4/5	4/5
CCP_M	4/5	4
CEP_M	4/5	3/4
CCP_D	4/5	3
CEP_D	4/5	4
VCP_L	4/5	4/5
VEP_L	4/5	4/5
VCP_M	4/5	4/5
VEP_M	4/5	4
VCP_D	4/5	4/5
VEP_D	4/5	4
LCP_L	4/5	4/5
LEP_L	4/5	4/5
LCP_M	4/5	4
LEP_M	4/5	4
LCP_D	4/5	4
LEP_D	4/5	4

Table 4. Result of rubbing fastness of dyed samples

Sample ID	Staining on multifibre fabric						Shade change of tested sample
	Acetate	Cotton	Nylon	PET	Acrylic	Wool	
CCP_L	4/5	4	4/5	4/5	4/5	4/5	4/5
CEP_L	4/5	4	4/5	4/5	4/5	4/5	4/5
CCP_M	4/5	4	4/5	4/5	4/5	4/5	4/5
CEP_M	4/5	4/5	4/5	4/5	4/5	4/5	4/5
CCP_D	4/5	3/4	4/5	4/5	4/5	4/5	4/5
CEP_D	4/5	4	4/5	4/5	4/5	4/5	4/5
VCP_L	4/5	4/5	4/5	4/5	4/5	4/5	4/5
VEP_L	4/5	4/5	4/5	4/5	4/5	4/5	4/5
VCP_M	4/5	4/5	4/5	4/5	4/5	4/5	4/5
VEP_M	4/5	4/5	4/5	4/5	4/5	4/5	4/5
VCP_D	4/5	4/5	4/5	4/5	4/5	4/5	4/5
VEP_D	4/5	4/5	4/5	4/5	4/5	4/5	4/5
LCP_L	4/5	4/5	4/5	4/5	4/5	4/5	4/5
LEP_L	4/5	4/5	4/5	4/5	4/5	4/5	4/5
LCP_M	4/5	4/5	4/5	4/5	4/5	4/5	4/5
LEP_M	4/5	4/5	4/5	4/5	4/5	4/5	4/5
LCP_D	4/5	4/5	4/5		4/5	4/5	4/5
LEP_D	4/5	4/5	4/5	4/5	4/5	4/5	4/5

Table 5. Results of wash fastness of dyed samples

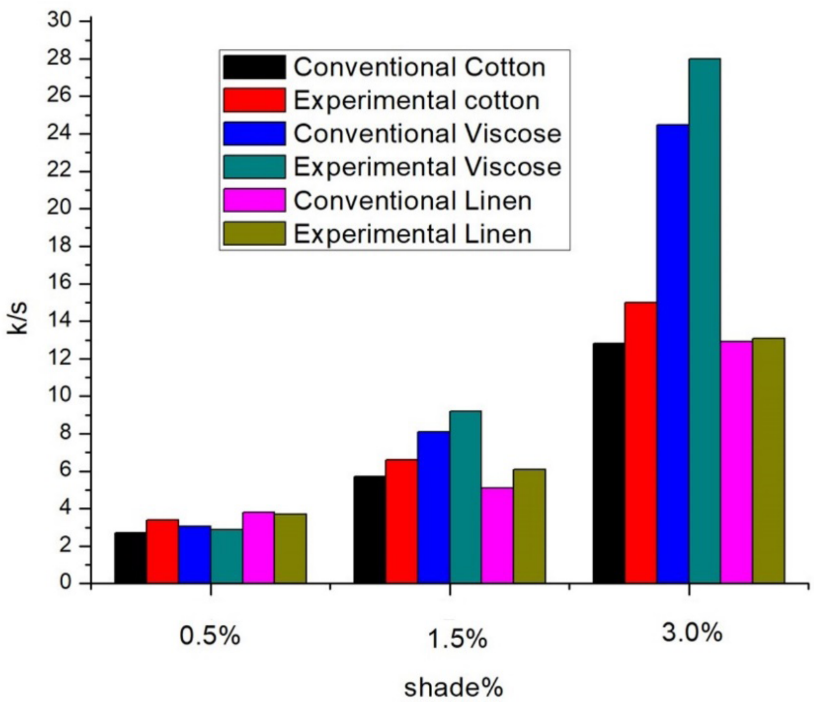

Fig. 3. K/S value for the samples

It is observed for viscose that the wash fastness result was the same for both the experimental (VEP_L, VEP_M, VEP_D) and conventional method samples (VCP_L, VCP_M, VCP_D) And the rating was good to excellent for both the staining and color change of the samples.

For linen fabric, the wash fastness result was the same for both the experimental (LEP_L, LEP_M, LEP_D) and conventional method samples (LCP_L, LCP_M, LCP_D) And the rating was good to excellent for both the staining and color change of the samples.

4. Conclusions

Single jersey cotton, viscose and linen fabrics were pretreated with a multiscouring agent, Viscobleach, where the same recipe was maintained for all three fabrics. And compared with the industrial regular pretreatment method of the three fabrics, cotton was pretreated with caustic soda and hydrogen peroxide, and viscose and linen with soda ash. Then followed dyeing at three shades for each fabric.

The whiteness index and absorbency of the cotton sample increased for the industrial regular method. whereas, the whiteness index and absorbency of viscose and linen samples increased for the experimental method. After dyeing, the K/S value of cotton was increased for all shades of the experimental method. For viscose & linen, the K/S

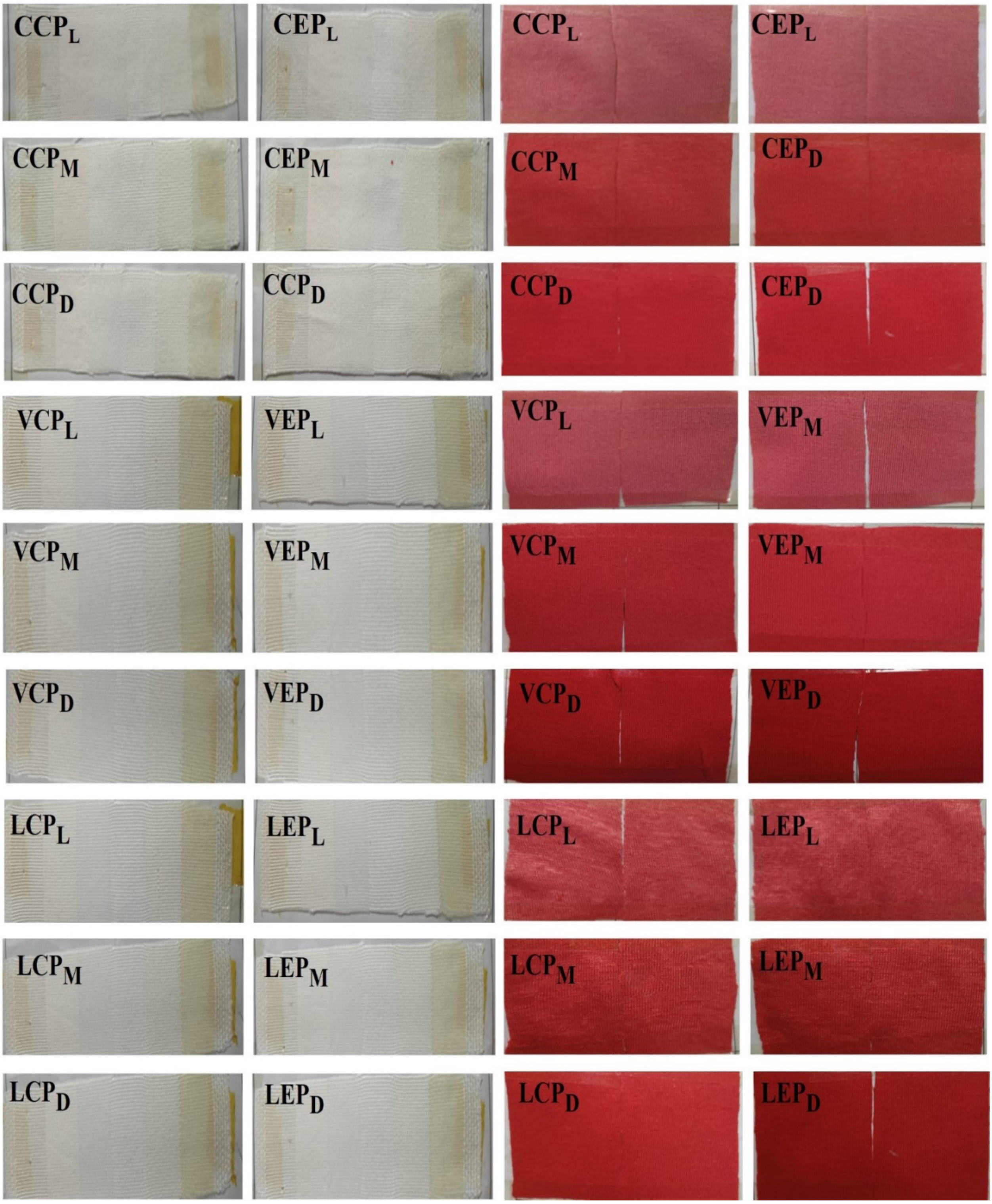

Fig. 4. Color fastness to washing (staining- left and fading -right)

value was increased for all medium & dark shades. This means that with the experimental method the dye pick-up % was higher and dye wastage less. In the case of cotton, the rubbing fastness of the experimental sample showed better results, and for viscose the industrial regular method (medium & dark shades) showed a better result. For linen, both samples showed the same result. The wash fastness result was almost the same for both the industrial regular method and experimental method. There were better results even for the medium and dark shades of the experimental method. The rating was almost good to excellent for all samples.

Thus, it can be inferred from the collected test results that if Viscobleach is used instead of the industrial regular method (with caustic soda or soda ash) in the pretreatment, the dyeing characteristics will be the same, and even better in some cases. The multiscouring agent is activated at low pH and temperature, as compared to industrial regular pretreatment, which reduces the process temperature, pH and energy consumption.

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References

1. MR M, F H, X L, Zakaria, H Q. A Study on the Effects of Pre-treatment in Dyeing Properties of Cotton Fabric and Impact on the Environment. J Text Sci Eng. 2016;06(05).
2. Trotman ER (Edward R. Dyeing and chemical technology of textile fibres. Griffin; 1970. 678 p.
3. Śmigiel-Kamińska D, Kumirska J, Wąs-Gubała J, Stepnowski P. The Identification of Cotton Fibers Dyed with Reactive Dyes for Forensic Purposes. Vol. 25, Molecules. MDPI; 2020.
4. Rippon JA, Evans DJ. Improving the properties of natural fibres by chemical treatments. In: Handbook of Natural Fibres: Volume 2: Processing and Applications. Elsevier Inc.; 2020. p. 245–321.
5. Broadbent AD, Society of Dyers and Colourists. Basic principles of textile coloration. Society of Dyers and Colorists; 2001. 578 p.
6. Khatri Z, Ahmed F, Jhatial AK, Abro MI, Mayakrishnan G, Kim IS. Cold pad-batch dyeing of cellulose nanofibers with reactive dyes. Cellulose. 2014;21(4):3089–95.
7. Mohsin M, Rasheed A, Farooq A, Ashraf M, Shah A. Environment friendly finishing of sulphur, vat, direct and reactive dyed cotton fabric. J Clean Prod. 2013 Aug 15;53:341–7.
8. Lewis DM. Colour and textile chemistry-a lucky career choice. 2009.
9. Akin DE, Gamble GR, Morrison H, Rigsby LL, Dodd RB. Chemical and Structural Analysis of Fibre and Core Tissues from Flax? Vol. 72, J Sci Food Agric. 1996.
10. Hamzah MA, Liu F, He LW, Cai YJ, Zhang P. Application of Multifunctional Scouring Agent for Cotton Fabric Bleaching. Adv Mat Res. 2015 Jul;1120–1121:193–7.
11. Buchert J, Pere J, Johansson LS, Campbell JM. Analysis of the surface chemistry of linen and cotton fabrics. Textile Research Journal. 2001;71(7):626–9.
12. Camper IP, Bott CB. Improvement of an industrial wastewater treatment system at a former viscose rayon plant-results from two-stage biological leachate treatability testing. 2006.
13. Herbert Morrison W, Akin DE. Chemical composition of components comprising bast tissue in flax. J Agric Food Chem. 2001;49(5):2333–8.
14. Bristi U, Pias AK, Lavlu FH. A Sustainable process by bio- scouring for cotton knitted fabric suitable for next generation. Journal of Textile Engineering & Fashion Technology. 2019 Feb 15;5(1).
15. Boryo DEA, Bello ; K A, Ibrahim ; A Q, Gin ; N S, Dauda ; T M, Elabo VO. Effect of Alternative Scouring Agents on Dyeing Properties of Cotton/Polyester Blend Fabric [Internet]. Vol. 5, IOSR Journal of Applied Chemistry (IOSR-JAC. Available from: www.iosrjournals.orgwww.iosrjournals.org
16. Basit A, Latif W, Baig SA, Rehman A, Hashim M, Zia Ur Rehman M. The mechanical and comfort properties of viscose with cotton and regenerated fibers blended woven fabrics. Medziagotyra. 2018;24(2):230–5.
17. R KM, Ramasamy KM, Kerebo Berekute A. A Scientific Approach on Pre-Treatment of Cotton Cloth using PVAMHCL (Poly-Vinyl-Amine-Chloride) for Salt Free/Low Salt Reactive Dyeing The Community Service Project Proposal on the Topic “Implementing Innovative Prints on the Hand Woven Cotton Cloth by Tie-dye Techniques” View project Reduction of textile dye by using heterogeneous photocatalysis View project A Scientific Approach on Pre-Treatment of Cotton Cloth using PVAMHCL (Poly-Vinyl-Amine-Chloride) for Salt Free/Low Salt Reactive Dyeing [Internet]. Vol. 6, IJSRD-International Journal for Scientific Research & Development|. 2018. Available from: https://www.researchgate.net/publication/330988537
18. Hamzah MA, Liu F, He LW, Cai YJ, Zhang P. Application of Multifunctional Scouring Agent for Cotton Fabric Bleaching. Adv Mat Res. 2015 Jul;1120–1121:193–7.
19. MR M, F H, X L, Zakaria, H Q. A Study on the Effects of Pre-treatment in Dyeing Properties of Cotton Fabric and Impact on the Environment. J Text Sci Eng. 2016;06(05).
20. Debasree Paul, Subrata Chandra Das, Tarikul Islam, Md. Abu Bakar Siddiquee, Md. Abdullah Al Mamun. Effect of Alkali Concentration on Dyeing Cotton Knitted Fabrics with Reactive Dyes. J Chem Chem Eng. 2017 Apr 28;11(4).
21. Dutta P. Economical and Sustainable Practices towards Knit-Dyeing Plant Utilizing Enzymes. International Journal of Emerging Trends in Engineering Research. 2020 Aug 25;8(8):4067–78.
22. Ibrahim NA, Eid BM, El-Batal H. A novel approach for adding smart functionalities to cellulosic fabrics. Carbohydr Polym. 2012 Jan 4;87(1):744–51.
23. Khatri A, Peerzada MH, Mohsin M, White M. A review on developments in dyeing cotton fabrics with reactive dyes for reducing effluent pollution. Vol. 87, Journal of Cleaner Production. Elsevier Ltd; 2015. p. 50–7.