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# ASSESSMENT OF QUALITY OF DYED FABRICS OF BIOSCOURED AND BLEACHED FABRIC WITH $H_2O_2$ SCOURING-BLEACHING

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**ABSTRACT**

Ehsan MN, Hossain MS, Tamanna NS (2016) Assessment of quality of dyed fabrics of bioscoured and bleached fabric with $H_2O_2$ scouring-bleaching. *Ins. Engg. Tech.* 6(1), 25-30.

A inclusive study on different pretreatment possibilities for knit fabric was undertaken to observe the quality of dyed fabric. Single jersey knit fabric was bioscoured using enzyme followed by bleaching with $H_2O_2$ (50%). Also conventional combined scouring and bleaching was performed using $H_2O_2$ and NaOH. Only bioscoured knit fabric without bleaching was also considered for dyeing deep shade. All three pretreated samples were dyed in the same bath for comparison among the processes. The color depth of different shade, color fastness to wash test, color fastness to light, color fastness to perspiration test, color fastness to rubbing were done for different pretreated samples for assessment. The assessment showed that environment friendly bioscoured samples could be considered for dyeing deep shade without bleaching for cost effectiveness. There are no significant differences found among different pretreated samples after dyeing deep shade in terms of quality assessment.

***Key words**: bioscouring, conventional scouring bleaching, color depth, wash fastness, perspiration fastness, rubbing fastness*

## INTRODUCTION

Cotton fibers consist of mainly high molecular weight, long chain cellulosic molecules that are polymerized from b-d-glucose monomers. Greige or untreated cotton contains various noncellulosic impurities, such as waxes, pectin, hemicelluloses and mineral salts, present in the cuticle and primary cell wall of the fiber (Batra 1985). These non-cellulosic components are mainly located in the outermost cuticle layer, (thickness 0.5–0.1 lm) and the primary wall of the cotton fibers. The non-cellulosic constituents are considered impurities that impart an undesirable color and hinder dyeing of cotton and are, therefore, removed by treatment with hot caustic soda solution prior to dyeing, printing and finishing of the material. Depending upon the variety of cotton, the quantity of these impurities ranges between 6% and 9% (Hardin *et al.* 2004).

The use of enzymes in the textile industry is an example of white industrial biotechnology, which allows the development of environmentally friendly technologies in fiber processing and strategies to improve the final product quality. The consumption of energy and raw-materials, as well as increased awareness of environmental concerns related to the use and disposal of chemicals into landfills, water or release into the air during chemical processing of textiles are the principal reasons for the application of enzymes in finishing of textile materials (O'Neill *et al.* 2007). Textile processing has benefited greatly in both environmental impact and product quality through the use of enzymes. From the 7000 enzymes known, only about 75 are commonly used in textile industry processes (Quandt and Kuhl, 2001).

## LITERATURE REVIEW

Scouring improves the wet ability of the fabric and normally uses alkalis, such as sodium hydroxide. However, these chemicals also attack the cellulose, leading to reduction in strength and loss of fabric weight. Furthermore, the resulting wastewater has a high COD (chemical oxygen demand), BOD (biological oxygen demand) and salt content (Buschle-Diller *et al.* 1998). Enzymatic or bioscouring, leaves the cellulose structure almost intact, preventing cellulose weight and strength loss. Bioscouring has a number of potential advantages over traditional scouring. It is performed at neutral pH, which reduces total water consumption, the treated yarn/fabrics retain their strength properties, the weight loss is reduced or limited compared with processing in traditional ways, and it increases cotton fibre softness (Rita *et al.* 2008). In generally cellulase and pectinase are combined and used for Bioscouring. In this pectinase destroy the cotton cuticle structure by digesting the pectin and removing the connection between the cuticle and the body of cotton fibre whereas cellulase can destroy cuticle structure by digesting the primary wall cellulose immediately under the cuticle of cotton. Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) of enzymatic scouring process are 20-45% as compared to alkaline scouring (100%). Total Dissolved Solid (TDS) of enzymatic scouring process is 20-50% as compared to alkaline scouring (100%). Handle is very soft in enzymatic scouring compared to harsh feel in alkaline scouring process. Enzymatic scouring makes it possible to effectively scour fabric without negatively affecting the fabric or the environment. It also minimizes health risks once operators are not exposed to aggressive chemicals (Pawar *et al*. 2002).

Enzymes are high molecular weight proteins that are produced by living organisms. These are composed of ca. 200–250 amino acids that catalyze (i.e. lower the activation energy) of many organic reactions without being consumed in the process. Enzyme activity can, however, be reduced or even completely destroyed (denatured) by high temperatures, extremes of pH and high concentrations of electrolytes that destroy their three-dimensional structures. Heavy metal ions and oxidizing and reducing agents also deactivate the enzymes.

Certain enzymes, however, require bivalent metal cations as activators to stabilize the structure of the enzyme–substrate complex. Enzymes or biocatalysts are very specific in their reactions and there is a different enzyme for each part of a series of reactions, such as those occurring in vegetable and animal life processes. The specificity of function of enzymes is often compared with the lock-and-key system, but actually their functioning is much more complex than this simple analogy might suggest (Shukla *et al.* 2000). Enzymes themselves are biodegradable and are converted into harmless substances in the effluent.

## MATERIALS AND METHODS

### Fabric Description

| Content | GSM | Structure | Count |
|---|---|---|---|
| 100% cotton | 120 | Single jersey knit fabric | 40s Combed Yarn |

### Chemicals

Wetting Agent, Lubricant, Leveling agent, Multi-functional Agent, Detergent, Enzyme, Peroxide Stabilizer, Caustic Soda, $H_2O_2$ (50%), Acetic Acid, Salt, Soap, Sequestering Agent, Reactive dye were of commercial grade chemicals.

### Treatments and methods of analysis of dyed sample

In this study three batches of same cotton fabric were considered for assessment. These three batches would be referred to as batch-1, batch-2 and batch-3 for convenience. Batch-1 was specified as only bioscoured sample, batch-2 was bioscoured followed by $H_2O_2$ bleaching and batch-3 indicates conventional scouring and bleaching process. Demineralization of all three batches of grey fabric were carried out with wetting Agent 2.00g/L, lubricant 2.00g/L, multi-functional Agent 2.00g/L, detergent 2.00g/L at 60°C for 20 minutes using material to a liquor ratio of 1:10. Batch 1 and batch 2 fabrics were bioscoured in the same machine using enzyme 1.00 g/L, detergent 0.20 g/L at 60°C for 60 min at pH 4.5 and the material to a liquor ratio of 1:10. The whole process of this bioscouring was carried out in a Tong Geng (Taiwan origin) sample dyeing machine. After the treatments the temperature was raised to 90°C and treated for 20 minutes and subsequently two cold wash for 5 minutes was done. Bleaching was carried out of bioscoured batch-2 with using $H_2O_2$(50%) 1.75 g/L, peroxide stabilizer 0.22 g/L at temperature 98°C at pH 10.5 for 50 min. Conventional scouring-bleaching of batch-3 was done in the same machine with bleaching solutions contained 1.75 g/L $H_2O_2$ (50%), Peroxide Stabilizer 0.22 g/L, Caustic Soda 1.80 g/L. All three batches were dyed together using reactive dye at pH 11.2 and temperature 60°C. After dyeing the substrates were neutralized using acetic acid and washed in hot water and subsequently fixing was completed using a dye fixing agent. The color depth was measured by internationally recognized spectrophotometer data color SF-600X.

### Process Recipes

Table 1. Process recipes

| Parameter & Chemical(g/L) Dye (%) | Bio-scouring | $H_2O_2$ Bleaching | Conventional Scouring bleaching | Dyeing | Neutralization & Soaping | Fixing |
|---|---|---|---|---|---|---|
| Enzyme | 1 | | | | | |
| Detergent | 0.2 | | 0.65 | | | |
| $H_2O_2$(50%) | | 1.75 | 1.75 | | | |
| Stabilizer | | 0.22 | 0.22 | | | |
| Wetting agent | | | 0.65 | | | |
| Lubricant | | | 0.65 | 0.65 | | |
| Seques. agent | | | 0.25 | 0.65 | | |
| Caustic Soda | | | 1.8 | 18 | | |
| Leveling agent | | | | 0.75 | | |
| Reactive Red 3GX | | | | 0.7612 % | | |
| Reactive Yellow | | | | 0.7571% | | |
| Reactive Black B | | | | 4.4532 % | | |
| Salt | | | | 60 | | |
| Acetic acid | | | | | 1 | 0.2 |
| Soap | | | | | 1 | |
| Fixing agent | | | | | | 1 |
| M:L | 1:10 | 1:10 | 1:10 | 1:10 | 1:10 | 1:10 |
| pH | 4.5 | 10.5 | 10.5 | 11.2 | 6.5 | 6.5 |
| Time | 60 min | 30 min | 50 min | 20 min | 10 min | 10 min |
| Temperature | 60°C | 98°C | 98°C | 60°C | 60°C | 40°C |

**Process curve**

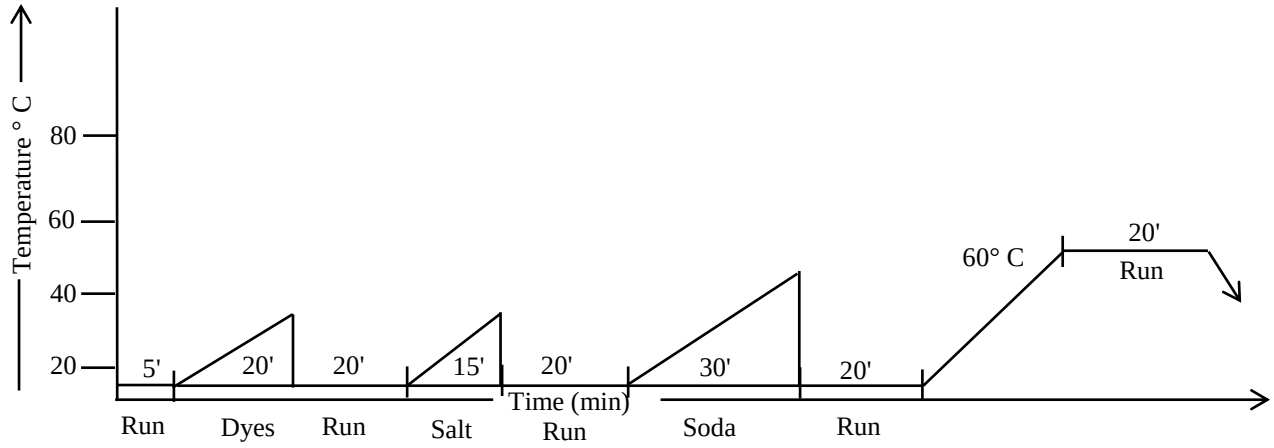



Fig. 1. Process curve for Dyeing

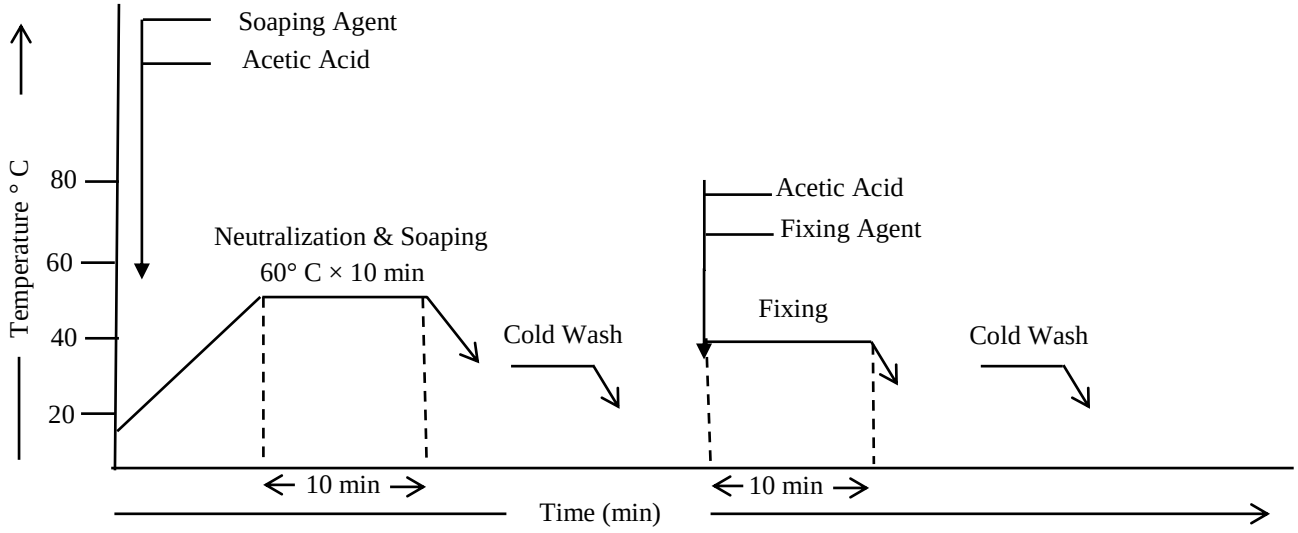



Fig. 2. Process curve for neutralization, soaping and fixing

## RESULT AND DISCUSSION

### Color Depth comparison

Three different pretreated batches (e.g batch-1, batch-2 and batch-3) were dyed in the same bath to observe the color depth. Three dissimilar light sources TL 83 10 Deg, D65 10 Deg and A 10 Deg were used for comparison. The color assessment was done according to the CIELab color space. The substrates were characterized by L* a* b* color coordinates. The efficiency of the processes (e. g. enzymatic pretreatment, conventional scouring bleaching), as well as the deviation between the reference and enzymatic treated samples were characterized by the color difference values. Color evenness of the treated fabrics of the dyed samples was also investigated. No considerable color difference was observed among three samples. So batch-1 (only bioscoured) sample can be considered for deep shade without doing bleaching.

Table 2. Spectrophotometer data analysis of bioscoured navy shade sample

| **Illum/Obs** | **Lightness DL** | **Saturation DC** | **Tone DH** | **CIE Lab value** | | **Total Color Deviation DE** | |
|---|---|---|---|---|---|---|---|
| | | | | Da | Db | | |
| TL 83 10 Deg | 0.84 | 1.58 | -0.13 | -0.45 More green | -1.74 More blue | 1.79 | Lighter More saturated More green |
| D65 10 Deg | 0.94 | 1.23 | 0.14 | -0.03 More green | -1.26 More blue | 1.55 | Lighter More saturated More red |
| A 10 Deg | 0.85 | 1.29 | -0.68 | -0.63 More green | -1.32 More blue | 1.68 | Lighter More saturated More green |

Table 3. Spectrophotometer data analysis of Bioscoured and $H_2O_2$ bleached navy shade sample

| Illum/Obs | Lightness DL | Saturation DC | Tone DH | CIE Lab value | | Total Color Deviation DE | |
|---|---|---|---|---|---|---|---|
| | | | | Da | Db | | |
| TL 83 10 Deg | 1.02 | 1.88 | -0.07 | -0.46 More green | -2.08 More blue | 2.14 | Lighter More saturated More green |
| D65 10 Deg | 1.16 | 1.44 | 0.16 | -0.04 More green | -1.47 More blue | 1.85 | Lighter More saturated More red |
| A 10 Deg | 1.05 | 1.52 | -0.70 | -0.67 More green | -1.56 More blue | 1.97 | Lighter More saturated More green |

Table 4. Spectrophotometer data analysis of Conventional Scoured Bleached navy shade sample

| Illum/Obs | Lightness DL | Saturation DC | Tone DH | CIE Lab value | | Total Color Deviation DE | |
|---|---|---|---|---|---|---|---|
| | | | | Da | Db | | |
| TL 83 10 Deg | 1.78 | 2.50 | -0.15 | -0.67 More green | -2.76 More blue | 3.07 | Lighter More saturated More green |
| D65 10 Deg | 1.96 | 1.94 | 0.17 | -0.09 More green | -1.99 More blue | 2.76 | Lighter More saturated More red |
| A 10 Deg | 1.83 | 2.07 | -0.82 | -0.83 More green | -2.12 More blue | 2.88 | Lighter More saturated More green |

(1) (2) (3)

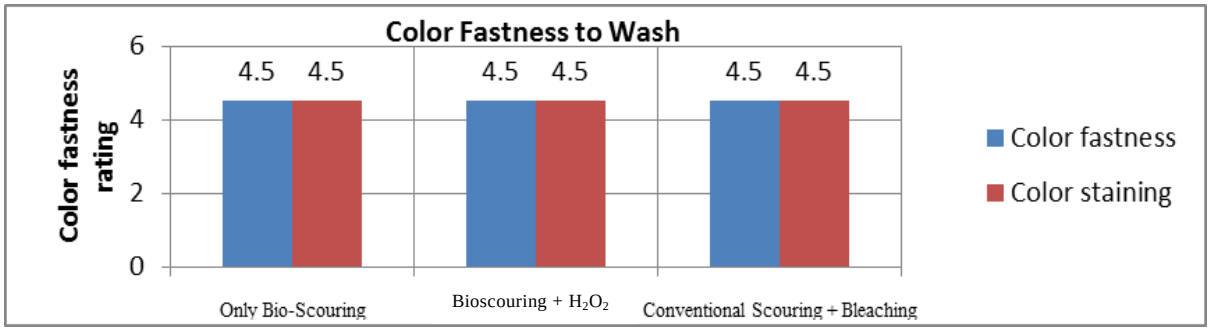
Fig. 3. (1) Only bioscoured sample (2) Bioscouring + $H_2O_2$ (3) Conventional scoured bleached

**Color fastness to wash**

Color fastness to wash was done using the test method ISO C03. This assessment was performed under standard light box of D65 (artificial day light). It was observed that the fastness of different batches (e.g. batch-1, batch-2, and batch-3) was same. There is no effect on wash fastness after following several methods of pretreatment.

Table 5. Color fastness to wash result

| Batch | Color Fastness to Wash | Color staining to the adjacent Multi-fiber fabric |
|---|---|---|
| 1. Only Bioscouring sample | 4/5 | 4/5 |
| 2. Bioscouring + $H_2O_2$ sample | 4/5 | 4/5 |
| 3. Conventional Scouring + Bleaching sample | 4/5 | 4/5 |

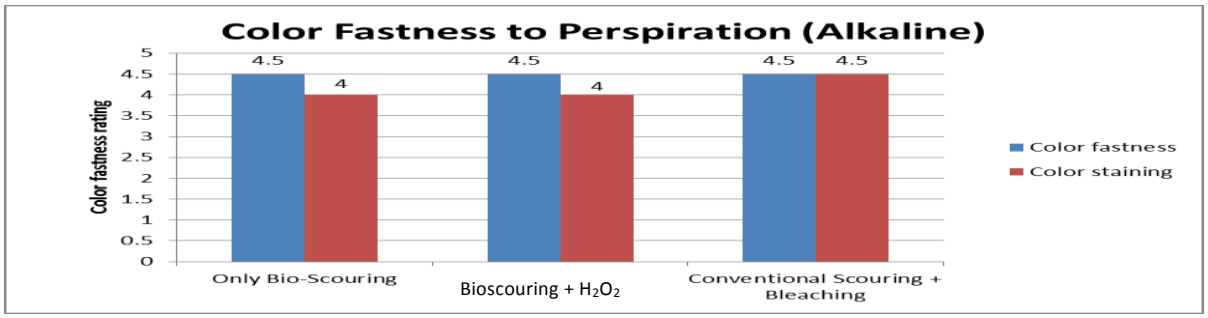


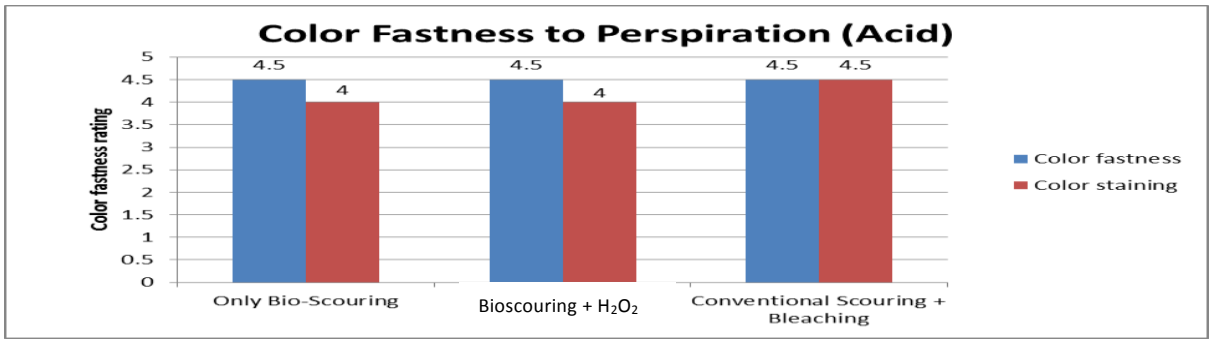
**Color fastness to perspiration**

Color fastness to perspiration was measured in both acid and alkaline medium and ISO 105E04 test method was followed to perform the test. Roaches UK perspirometer was used to conduct the experiment. No significant differences were found except there are some differences for batch-1 and batch-2 for staining fastness.

Table 6. Color fastness to perspiration result

| Batch | Color Fastness to Perspiration | Color staining to the adjacent Multi-fiber fabric |
|---|---|---|
| 1. Only Bioscouring | Alkaline: 4/5,Acid: 4/5 | Alkaline: 4,Acid: 4 |
| 2. Bioscouring + $H_2O_2$ | Alkaline: 4/5,Acid: 4/5 | Alkaline: 4,Acid: 4 |
| 3. Conventional Scouring + Bleaching | Alkaline: 4/5,Acid: 4/5 | Alkaline: 4/5,Acid: 4/5 |



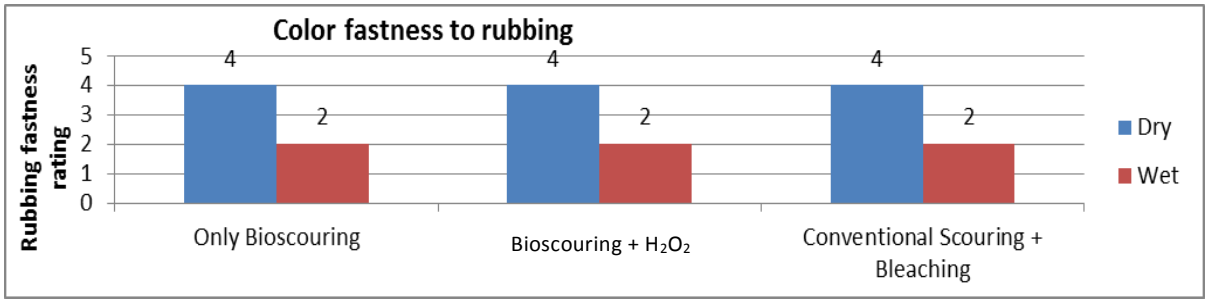




**Color fastness to rubbing test**

Color fastness to rubbing test was carried out in James Heal UK origin crock meter following the test method ISO 105X12 and the result was same for each batch. This is because the rubbing mainly depends on the quality of fabric, not the pretreatment processes.

Table 7. Color fastness to rubbing result

| Batch | Dry | Wet |
|---|---|---|
| 1. Only Bioscouring | 4 | 2 |
| 2. Bioscouring + $H_2O_2$ | 4 | 2 |
| 3. Conventional Scouring + Bleaching | 4 | 2 |




**CONCLUSION**

Enzymes can be used in order to develop environmental friendly substitutes to chemical methods in almost all steps of textile fiber processing. A thorough investigation on deep shade dyeing of differently pretreated fabric was undertaken in this paper. Pretreatment possibilities include conventional scouring bleaching, only bioscouring and bioscouring followed by $H_2O_2$ bleaching. It was observed that in the case of deep shade dyeing, bioscouring is cost effective because conventional scouring bleaching includes an extra process (e.g bleaching) which produces cost and is also not environment-friendly. For only bioscoured sample an extra process can be

avoided. On the other hand quality parameters of dyed fabric for three different types of pretreated fabric are almost similar. Further research is required for the implementation of other enzymes for bleaching of cotton fabric instead of conventional bleaching.

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