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HAZARDOUS FREE AND NATURAL COLORIZATION OF BLENDED FABRIC UTILIZING COFFEE WITH THE ATTAINMENT OF ACCEPTABLE FUNCTIONAL PROPERTIES

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ABSTRACT

In this study, blended fabric like 65% polyester 33% rayon 2% spandex was naturally dyed utilizing coffee with maintaining of all the quality parameters. In the coffee-dyed fabric, carcinogenic element like formaldehyde was not detected. The bursting strength of the fabric was unchanged after dyeing and the fabric composition was identically tantamount. The color levelness of the dyed fabric was satisfactory and the color fastness to washing rating was 4-5. Colorfastness to perspiration in both acid and alkali medium was excellent containing a rating of 4-5. The naturally dyed fabric was able to hinder the microbial effect, and the entire dyeing procedure was convenient. Due to the absence of detrimental elements, the coffee-dyed fabric could be utilized to prepare hygienic garments items; baby wears products. The main function of this article is to enhance the functional properties of traditional fabric which is improving with the utilization of natural ingredients.

Keywords: *Formaldehyde, carcinogenic, color fastness, longevity*.

1. INTRODUCTION

Dyeing is a crucial part of the textile industry to have an aesthetic look of raw fabric. This not only makes the fabric more attractive but also increases its functionalities. To accomplish this stage, we have to use different types of dyes, pigments, and harmful chemicals (Adeel et. al, 2009). This not only makes the fabric more attractive, but also increases its durability, increases light fastness, wash fastness, perspiration fastness, rubbing fastness, fastness to chlorinated water, sublimation fastness, dry-cleaning fastness etc. For attaining more value to textile material, we always should choose proper dyes and perfect dyeing procedure (Shamey et al., 2005). Some auxiliaries are used in parallel with dyes. These auxiliaries have also influence on textile dyeing. Therefore, compatibility of dyes and auxiliaries should be maintained and dyes should not interact with auxiliaries. There are different types of dyes available. Usually we use natural and synthetic dyes for dyeing. Natural dyes are obtained from natural source and synthetic dyes are manufactured chemically (Siva, 2007). But due to the unavailability of natural dyes or for complex extraction system, we have to use synthetic dyes most of the time. But this section of the textile industry has a detrimental impact on our environment, more precisely on water. In every industry, Effluent Treatment Plant (ETP) has been used to mitigate the pollution of water (Khan et al., 2009). An industry has to invest in purifying the water which is not economical. Besides pollution, several chemicals can be a minacious for the human body.

Now days the factories which are running in Bangladesh and also all over the world basically utilized for colorization and processing purposes the chemicals are synthetic dyes. The dyes are normally produced though polymerization and during polymerization the manufacturing is dyes and chemicals a lot of reaction happen. And during the chain reaction the other reaction which are happen the manufacturing process. The dyes or the chemicals become a specific portion of hazarding ingredients. And after utilizing of the specific dyes and chemical for the processing purposes of the specific fabric the functional purpose will exist but after dyeing or processing when the waste water or the utilized water are discharged to the environment then it causes harmful effect. Because most of the time the water is not treated. And without treatment of the processing water, the discharged water causes a great detrimental effect to the environment. In contrast to that if it is possible to utilized the natural ingredients for any textile processing purpose or colorization purposes then the whole

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scenario will be changed and it will be beneficial for the environment. Apart from that it will be also cost economical.

Synthetic dyes are frequently used in the textile industry (Forgacs et al., 2004). They are versatile and feasible in providing and maintaining the functionalities of fabric which are imperative for further processes. In addition, these dyes can be harmful to the skin, especially when it comes to the body contact there can be seen various spots or rashes (Dweck, 2002). Most of the time the procedure of making of synthetic dyes are not environment friendly. It pollutes the air generally which creates long term adverse effects on environment. Most importantly the residuals of textile dyes which are ejected from dyeing section after dyeing have a vast negative impact on environment (Katheresan et al., 2018). In poor and developing countries, dyeing industries passes the hazardous dyes and associated chemicals to the rivers and canals without any treatment of waste water. The waste of these synthetic dyes mixes with river water, which is responsible for the pollution of river water (Pearce et al., 2003). Then it becomes difficult for fish and under water lives to survive in this water. Hence the ecological balance is hampered. Besides, when the hazardous synthetic dyes are absorbed and mixes with soil, then soil pollution occurs (Vinu et al., 2012). Fertility of soil is decreased. Basically synthetic dyes are normally used to improve the functional properties of the fabric but the main reason of the of the using synthetic dyes and the synthetic chemicals are the hazardous elements specially the Azo, formaldehyde, which degrades the hygienic effect of the fabric in contrast to that the natural dyes and ingredients which have been utilized in this particular paper. The presence of the hazardous elements basically the metal components like as Azo and formaldehyde, its indicates that which is below that the standard hazardous limit. So, this can show that the presences of the hazardous elements are not in the natural ingredients which are used in the particular paper. And the most important thing is that the natural ingredients has the special characteristics to modify the functional properties because natural ingredients has the special binding agent embedded in their substances also the natural dyes have some ingrained properties which alter the functional properties of the fabric, which is required for our desired purposes.

Then it hampers the growth of plants. Sometimes soil pollution gets such a level that no plant can grow there. Thus, ecological balance can be hampered badly. Also these wastes spread bad smell which makes air pollution (Amaeze et al., 2012) which creates respiratory problem of human being. In this regard, Effluent Treatment Plant (ETP) should be installed in factories to treat these harmful wastes. But it needs a large scale investment to settle and run an Effluent Treatment Plant (ETP). So, industry owners of poor or developing countries do not want to run an Effluent Treatment Plant (ETP) and adverse consequences are going on (Aktar, 2014). That's why we should think of an environment friendly, affordable system. When it comes to health issues and the environment, we have to think about an alternative way. Natural dyes are the only way, though it is not easy to achieve the required properties that we get by using synthetic dyes (Hug et al., 2014). In order to reduce the negative impact of dyeing, we have to think about natural dyes in place of synthetic dyes. Many resources in our surroundings can produce a wide range of colors with different functionalities (Goodwin, 2000).

As an alternative of synthetic dyes natural dyes are of a good choice, because it is bio-degradable, non-toxic, environment friendly, aesthetically appealing, and easy extraction of colors from its sources (Das, 2011). There are two major impacts come from using natural dyes and they are minimal environmental impact and renewability. Many experiments have been done on textile goods using natural sources and which already added value to the textile industry and textile production (Samanta et al., 2011). Coffee is a natural ingredient. We can dye the fiber/yarn/fabric using its dyes. On examination, the use of this color has increased the quality of the fabric, appealing it more aesthetic, increased the brightness, increased the water holding capacity, and increased the color fastness & wash fastness compared to synthetic dyeing. Also the antibacterial power is increasing several times more than before. On top of that, it is relatively affordable, easy to find, environmentally friendly, and does not damage the skin. Since there are no harmful ingredients, this coffee can be used to make any sensitive fabric. In the near future, all the synthetic substances that are harmful will be replaced by various natural ingredients.

2. MATERIALS AND METHODS

2.1 Fabric description

Composition: 65% polyester, 3% rayon and 2% spandex, 180 G.S.M.
Construction: Single
GSM: 150

2.2 Natural ingredient

Natural ingredients like coffee was used.Aloe Vera, Neem, Holy Basil (Tulsi) leaves were used for natural finishing.

2.3 Extraction of dye & finishing solution from natural ingredients

i. Firstly, the required ingredient (coffee) was gathered and washed properly by using water.
ii. Ingredient was crushed and turned into paste form.
iii. The paste was heated at a certain temperature.
iv. After boiling the exudates were filtered.

At first the natural ingredients are selected after the selection then it was clear from any dust particles or any solid particles and after that the natural ingredients were washed with hot water and then thoroughly with clean water. And after proper cleaning of the natural ingredients, the natural ingredients was grinded properly to collect the sap from the natural ingredient. After the collection of the sap and the sap was filtered to obtained the clear liquid from the ingredients which will be used for different purposes.

2.4 Pretreatment of blended fabric fibers

It was indispensable to make the raw blended fabric fiber clean and to remove the natural color as well to convert it into hydrophilic condition. For this purpose, the pretreatment process (scouring and bleaching) was carried out simultaneously. Material and liquid ratio (M: L) for the scouring and bleaching process was kept at 1:20. The weight of the selected blended fabric was 14 g. The electrical balance and automatic pipette were used for measurement purposes throughout the procedure. After that, a calculated amount of water (280 ml) was taken into a hollow cylindrical shape nozzle (made of stainless steel) of the lab fabric dyeing machine.

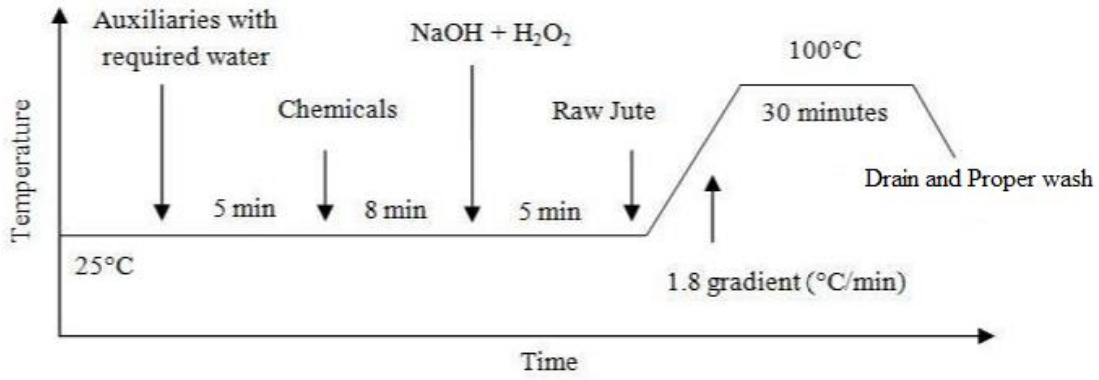

Figure 1: process curve of pretreatment

NaOH and H_2O_2 were added into the nozzle under the controlled condition at room temperature (25 °C) according to the recipe followed by the addition of requisite chemicals and auxiliaries. All the chemicals were mixed properly at ambient temperature and controlled conditions prior to the addition of blended fabric. If the used NaOH and H_2O_2 were added after the inclusion of raw blended fabric into the nozzle or during the increment of temperature, there would be the possibility of uneven color absorption of blended fabric sample which could degrade the quality of the fiber. That's why the raw blended fabric was placed into the nozzle after the proper addition of NaOH and H_2O_2 at room temperature without occurring any unwanted explosion. Then the machine temperature was raised to 100 °C and kept fixed for 30 minutes while the pH of the medium was around 10.8. After the completion of the required time, the fabric was taken out from the nozzle and washed properly to remove the residual chemicals. Acetic acid (CH_3-COOH) was added at 1 $gL^{-1}$to convert the medium from alkaline to neutral condition. It was required a total of 1.5 hours to complete the pretreatment process including the time consumed to raise the temperature from 25 °C to 100 °C using 1.8 temperature gradient (°C/min).

2.5 Dyeing of blended fabric

Pretreated blended fabric (scoured and bleached) was in an amiable condition to initiate dyeing with natural dyes. The material and liquid ratio (M: L) for the dyeing process was set at 1:20. The required amount of water

(280 ml) was taken in a nozzle as per the M: L ratio. After the addition of dyeing auxiliaries exemplifies sequestering agent (Lufibrol®antoxliq) and leveling agent (Invalon®), then the pretreated blended fabric was placed into the nozzle. The machine temperature was increased to 60 °C and during the rise of temperature; the extracted coffee liquid was added into the solution. After the completion of 10 minutes running condition at 60 °C, Potassium alum - $KAl(SO_4)_2.12H_2O$ was added into the solution and the action was continued for another 20 minutes. After that sample fabric was removed from the nozzle and washed properly including a cold and hot wash.

For finishing purpose, Aloe Vera, neem, and Holy Basil (Tulsi) paste were used. Firstly, the required ingredients were turn into paste form, then adequate amount of water have been added to turn the paste into juicy liquor so that the finishers can easily penetrate into the dyed fabric sample. The finishing treatment was continued for 1 hour at 60^oC. After finishing treatment, the sample was rinsed with water for three times so that the surface particles (of the liquor) may be removed. When fabric dyeing with natural dyes was completed & after the application of natural finish, the dyed fabric was slightly washed & allowed to dry properly.

3. RESULTS AND DISCUSSIONS

The color quality of the processed fabric was checked under the D65 light source in a light box. The dyed fabric was free from any foreign color spot and the color levelness of the fabric surface was satisfactory. There was no crease mark formation and no color unevenness on the fabric was found. The color fastness to wash test was carried out for the dyed samples & the test procedure was ISO-105-C06 method. After carried out testing, multi-fiber fabric was checked to understand the fastness rating. Color fastness to wash rating was 4-5. Moreover, color fastness to perspiration for both acid and alkali medium was also 4-5. Bursting strength of both the dyed fabric and raw fabric was measured and a comparison was also carried out using the obtained values. Diaphragm bursting strength test (British Standard 3424 Method) was followed for this measurement. The average value of bursting strength of both dyed and raw fabric was estimated by recurring the test 5 times.

Table 1: Bursting strength of a dyed fabric

Serial No.	Dyed Fabric		Raw Fabric	
	Bursting Strength (KNm^{-2})	Mean Value	Bursting Strength (KNm^{-2})	Mean Value
1	578.8	579.9	598.9	596.9
2	577.5		594.8	
3	576.9		595.5	
4	579.5		598.4	
5	586.8		597.1	

Figure 2: antimicrobial test of treated and untreated jute fabric a) with "Staphylococcus aureus" and b) with "Salmonella bacillus"

It was found that the mean bursting strength of dyed fabric was 579.9 $KNm^{-2}$and the mean bursting strength of raw fabric was 596.9 KNm^{-2}. The bursting strength of the dyed fabric was not deteriorated. The antimicrobial test for dyed and untreated samples was checked using the disk diffusion method against Staphylococcus aureus and Salmonella bacillus bacteria. While the antibiotics hindered the growth of the bacterium, the formation of the specific area surrounding the wafers depicted that the growth of bacteria was inhibited. It was observed that the inhibition zone of dyed fabric showed antimicrobial activity against both Staphylococcus aureus and Salmonella bacillus bacteria whereas the untreated raw fabric could not show the same characteristics.

The morphological structure of the dyed fabric and raw fabric was checked by utilizing a scanning electron microscope (SEM) and the changes between their structures were also observed. In comparison to that this amorphous region of the dyed sample was reduced which meant that the crystallinity of the dyed sample was ameliorated. The compactness of the fiber was improved for the dyed sample which ultimately increased the performance.

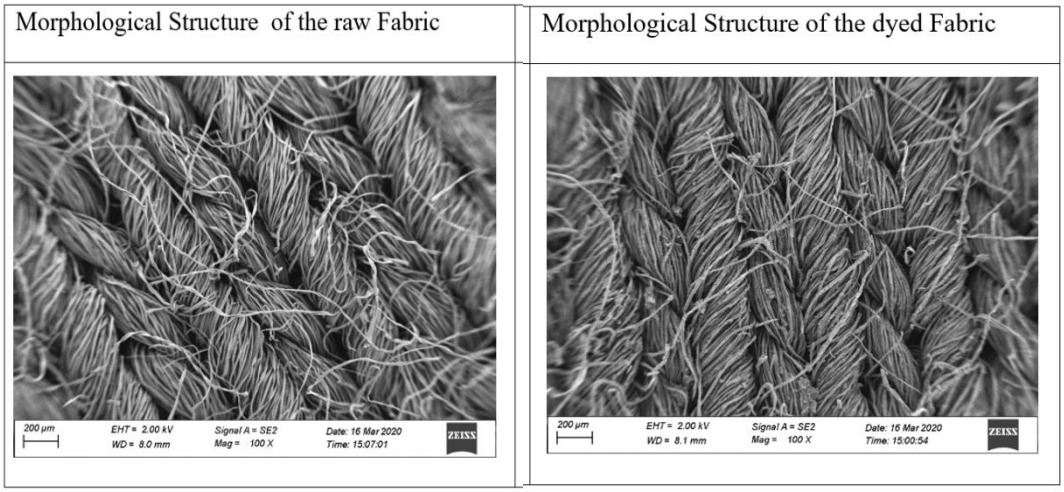

Figure 3: SEM test of the raw and dyed sample under different magnification

Formaldehyde content of the dyed fabric was tested and was not detected. The cost of the total dyeing procedure was less than dyeing with synthetic dyes. So, the use of coffee can be replaced for dyeing the textile fabric.

Table 2: formaldehyde test result of the dyed sample

TÜV SÜD South Asia

Test	Result
Formaldehyde Content	PASS

Pass = Meet Standard's Client Specs Fail = Below Standard's Client Specs # = No Comment

Figure 4: picture of the dyed sample

The strength of the color was good and we find it from the result of the color fastness to wash and color fastness to rubbing. When the dyed sample was test or viewed under D65 light sourced or spectrophotometer the under

the light sourced it was shown there the no formation of unevenness or unevenness in the dyed fabric. And together with there is no presence of spot in the dyed fabric. So all of this observation illustrated that the dyed sample was free from any unevenness and the formation of dyeing was perfect.

4. CONCLUSIONS

In this work, natural dye was applied on the blended fabric. Acceptable results obtained in various testing such as color fastness to wash, perspiration tests. Main success is that without using any salt, soda or other chemicals it becomes successful to dye with natural ingredient. From this research this has come to know that the natural dye can provide giving better dyeing result on blended fabric. This natural dyeing is environmentally friendly, cost effective, less time consuming & good quality. The basic target considering the environmental issue as well as the quality factors of natural fabric dyeing was achieved & wide range of colors can be achieved with natural dye. If we compare with the specific dyeing with the traditional dyeing then the total utilization of the dyeing will be at least 20% less than the traditional dyeing. And regarding the cost issue the tradition al dyeing will be more than 20% to 30% cost increasing than the specific dyeing. So we can say that our submitted article which was dyed with natural ingredients have the cost effect is more and which is helpful for maintaining the cost minimization in the factory.

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