



The Effect of Natural Reducing Agents on Denim Fabric for the Amelioration of Natural Fading Effect Via Environmental Friendly Approach

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Abstract: Color fading of denim fabric was done in this study by using natural reducing agent to make environment friendly effect and reduce toxicity for the application of chemical process on denim fabric. Different natural reducing agents such as; lemon, tomatoes, tamarind, sugarcane, pineapple barks, edible root, dubbed sloughs, emblica, cucumber, palm cabbage sloughs, grape, lotkon, carambola were used. Denim fabric was rubbed 20-30 times by these natural reducing agents. Denim fabric was dried atmospherically after manual process of fading. The fabric was washed with 1-2% detergent at room temperature then dried at 80°C. Color difference value, CMC value, stiffness, tensile strength, whiteness index (°CIE), the GSM of naturally faded denim fabric was also investigated to make a comparison with chemically faded denim.

Keywords: Natural Reducing Agent, Chemical Treatment, Denim Fabric, Fading Effect, CIE, Environment Friendly

1. Introduction

Color fading of textile fabric has become a popular trend in the 21st century. It is believed that this great mass fervor will keep growing in the coming years. This incentive has led to increasing interests in the development of various techniques for the color fading of textile products in the textile industry [1]. Designer jeans as well as premium jeans first influenced a small group of luxury consumers, but now consumers from all social and economic classes embrace them. Challenges faced by denim apparel manufacturers and fashion designers include the need for reinventing products for niche markets, and meeting consumer demands for better

apparel sizing [2]. Denim Jeans finishing is one of the most extensively used finishing treatments that have enormous practice, because of its effects on appearance and comfort [3]. There are almost countless variations of dry and wet processing techniques used by designers and textile chemists to achieve fashionable looks that are distinctive and desirable [4-6]. Traditionally, there are several existing methods which can produce the effect of textile color fading such as stone washing, bio-stoning and sandblasting [7]. Discoloration of indigo dyed denim garment along with color free effluent is introduced by using a combination of bio and nano-treatment

that producing lower indigo staining on the denim garment [8]. However, these kinds of processes usually cause substantial deterioration or degradation of the fabric. Besides, bleaching solutions containing chlorine or rubbing the garment with sand or stones to produce the old look effect could cause damage to the fabric which in turn affects its wear life [9]. Furthermore, the environmental problems is more concerned in recent years, people are trying to find out some new ways that is more economical and environmentally friendly as the conventional color fading processes involves large amount of water consumption and most of which are contaminated by chemicals used in the process [7]. Plasma technology which is being applied on the textiles aspects over the last two decades is a dry process without using any chemical [10]. It is believed that the eco-friendly nature of the process is a particular advantage over other conventional color fading processes [11]. In recent years, there has been increasing interest in the use of environmentally friendly, nontoxic, fully biodegradable enzymes in the modern textile technology finishing process. Enzymatic treatment can replace a number of mechanical and chemical operations, which have been applied to improve the comfort and quality of fabrics [12, 13]. In the textile industry enzymes are applied mainly to get a cleaner fabric surface with less fuzz, to reduce tendency to pill formation, to improve handle, to smooth the surface combining with traditional softeners. The development studies of this area have been focused on applying enzymes on cellulose materials based on cotton, linen, viscose and their blends with synthetics fibers [14]. In previous study bio washing using neutral cellulose enzyme and liquid ammonia treatment was done on denim fabric that increased softness, created a fade-out effect with natural color. However it failed to give proper strength and elastic recovery on denim fabric due to the enzyme that damaged the cellulose [15]. Traditionally, there are plenty of technologies such as sanding, sand blasting, stone washing, brushing, bleaching, bio-stoning and etc., can be used for textile color fading. However, these kinds of technologies have a lot of inherent disadvantages [7]. In this research work, different kinds of plants and fruits were used to carry out the color fading of a group of vat dye dyed textile materials. Finally, the evaluation of the color fading performance was carried out by using natural reducing agents to develop color fading on denim by using natural resource for keeping accepted quality with better performance. Evaluation of the treated sample was done by CMC, Whiteness index, Tensile Strength, Stiffness and GSM.

2. Experimental

2.1. Materials

100% cotton twill weave (3/1 Left Hand Twill, GSM 381), indigo dyed denim fabric was supplied from Ha-meem Denim Limited. Lemon, tomatoes, tamarind, sugarcane, pineapple barks, edible root, dubbed sloughs, emblica, cucumber, palm cabbage sloughs, grape, lotkon, carambola

was collected from various regions of Bangladesh.

2.2. Methods

Methods of natural and chemical fading on denim fabric

Different natural fading effect was done on denim fabric by rubbing (20-30 times) with various natural reducing agent such as lemon, tomatoes, tamarind, sugarcane, pineapple barks, edible root, dubbed sloughs, emblica, cucumber, palm cabbage sloughs, grape, lotkon, carambola. The denim fabrics were dried atmospherically after manual fading process. Denim fabric was washed with 1-2% detergent at a room temperature and dried at 80 °c.

3. Test Procedure

Tensile strength was measured by following ASTM-D-5035(1995) method using Instron tensile tester (Model No. 5565) [16]. Stiffness was evaluated according to ASTM-D-1388 method. GSM was determined by ASTM-D-3776 method. Whiteness index and color differences were recorded using spectrophotometer 968(X-rite, USA) with setting D65 illuminant [17] and 10°C observer. CMC value was measured by AATCC-173 method.

4. Result and Discussion

4.1. Color Differences Value of Naturally and Chemically Faded Denim Fabric

Table 1. Color differences value of naturally and chemically faded denim fabric.

Natural washed denim	Unfaded			Natural		
	L*	a*	b*	L*	a*	b*
Tamarind				22.91	-0.75	-14.24
Dubbed Sloughs				26.89	-2.25	-11.43
Edible Root				22.50	-0.55	-13.70
Sugarcane				24.18	-0.42	-14.41
Pineapple barks				23.84	-0.79	-14.95
Tomatoes	19.54	-0.46	-11.56	21.90	-0.16	-14.07
Carambola				21.39	0.03	-14.47
Lemons				21.23	-0.00	-14.00
Emblica				22.42	-0.36	-14.57
Cucumber				21.17	-0.49	-12.84
Lotkon				20.78	-0.57	-11.54
Palm-cabbage Sloughs				19.58	0.19	-12.41
Grape				21.14	-0.41	-12.58

Table 1 shows color differences value for naturally faded denim fabric. It can be seen from the table above that every faded denim fabric gave good L* value compared with unfaded value especially dubbed sloughs, pineapple, tamarind and sugarcane which gave better result from other sources because, they are contain acids which reacts with vat dye to remove color from the denim fabric. In the case of some natural sources, a* value decreased as a result of color change from deep green to light also from deep red to light red. Carambola, tomatoes, lemons, palm-cabbage sloughs gave better result compared to the others. It may be because

the acid reacted with vat dye which resulted in the color fading effect. In case of b*value (Natural fading) color changed from light blue to deep blue. Carambola, Pineapple

barks and Lotcon exhibited more blue rather than the other sources.

Table 2. Color differences value of chemically faded denim fabric.

Chemical washed denim	Unfaded			Chemical		
	L*	a*	b*	L*	a*	b*
Enzyme with stone				27.22	0.17	-9.87
Enzyme Without stone				23.18	-0.24	-12.07
Only stone	19.54	-0.46	-11.56	25.43	-0.40	-11.69
Laser				27.87	-1.49	-8.74
Desized				23.83	-0.34	-10.94

Table 2. Color differences value of chemically faded denim fabric.

shows color difference value due to chemical fading effect where L*value of enzyme and laser gave better result compared to the other samples. For a* values color changed from deep green to light green and enzyme with stone washed denim fabric showed color change from deep green

to light red. Laser showed color change from light green to deep green. In case of b*value (Chemical fading) color changed from deep blue to light blue whereas enzyme without stone and only stone exhibited higher b value compared with natural fading.

4.2. Whiteness Index Value of Naturally and Chemically Faded Denim Fabric

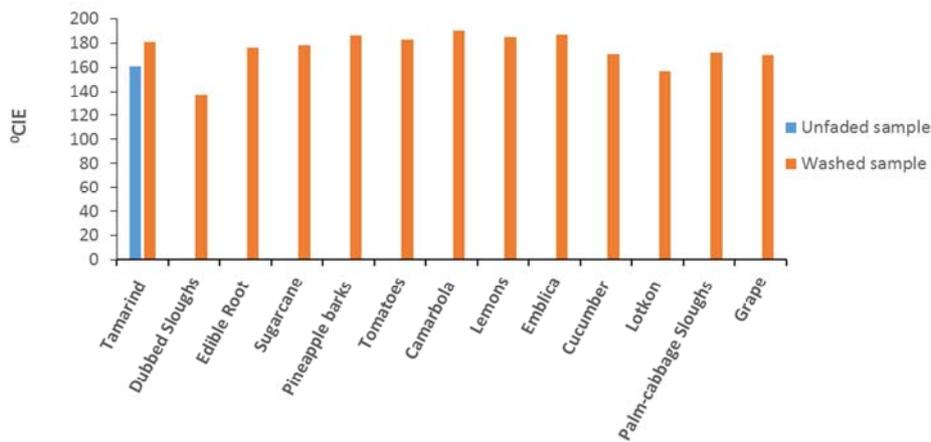


Figure 1. CIE Whiteness Index value of naturally faded denim fabric.

During fading by natural resource it is clearly seen from

Figure 1 that, samples which were rubbed by Tamarind, Pineapple barks, Carambola, Lemons, Tomatoes and Amblica exhibited higher CIE whiteness index compared with the

whiteness of the unfaded sample. On the other hand from Figure 2 it can be seen that during chemical fading whiteness increased more than that of the unfaded sample.

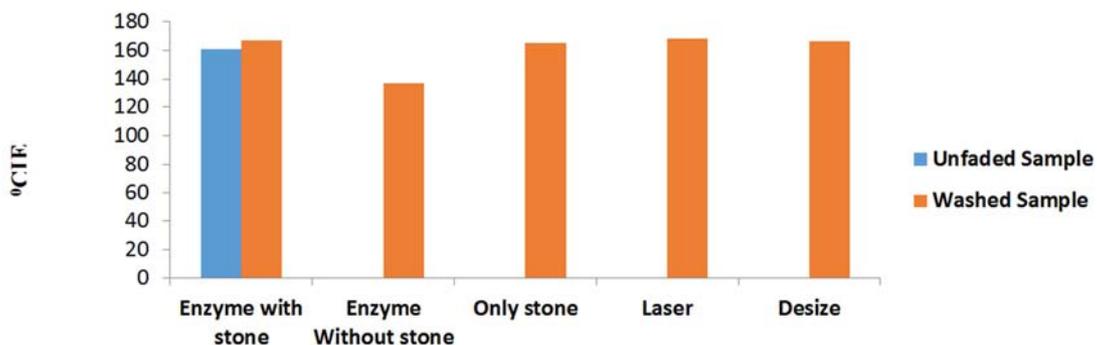


Figure 2. CIE Whiteness Index value of chemically faded denim fabric.

4.3. CMC Value of Naturally and Chemically Faded Denim Fabric

Figure 3 represents CMC value of naturally faded denim fabric where dubbed Sloughs, sugarcane, pineapple barks and

tamarind exhibits higher color difference. Because those sources contain acid which react with vat dye and remove dye from the sample.

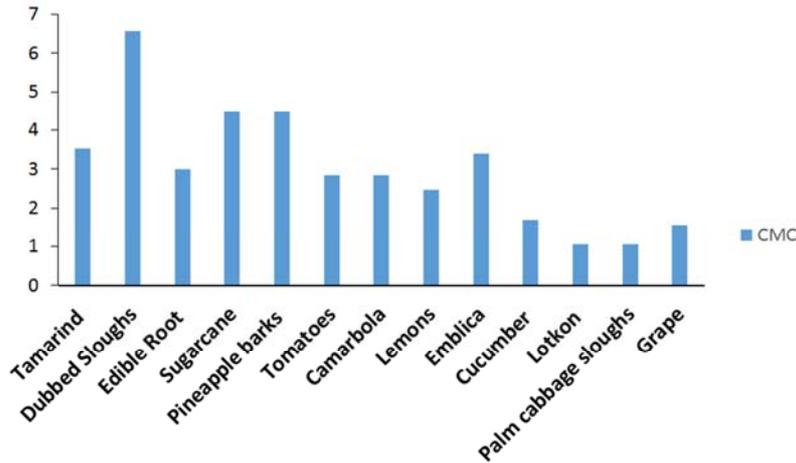


Figure 3. CMC value of naturally faded denim fabric.

When denim was treated with Laser or enzyme with stone, it gave higher color difference than the natural fading technique (Figure 4).

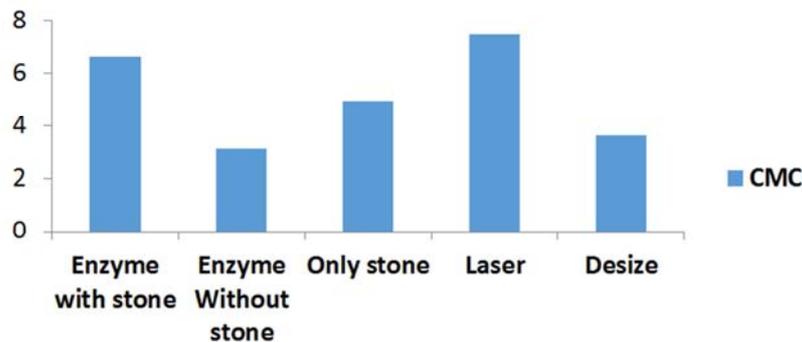


Figure 4. CMC value of chemically faded denim fabric.

4.4. Tensile Strength of Naturally and Chemically Faded Denim Fabric

From Figure 5 it was seen that, better result was found for tensile strength in warp direction due to natural fading of Tamarind and Lotcon. Again in weft direction better results were due to natural fading of Edible Root, Carambola and Lemons (Figure 6).

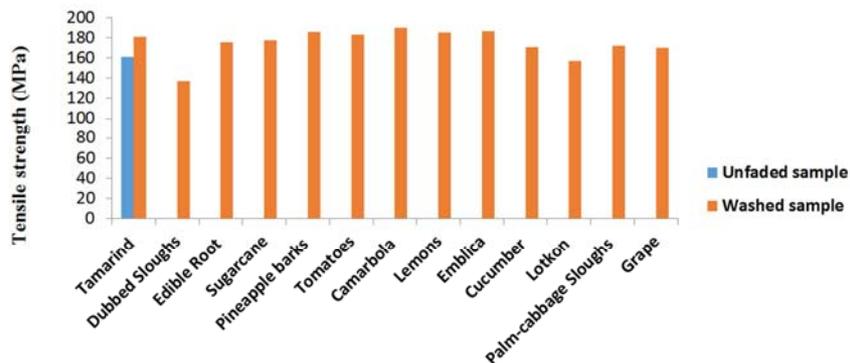


Figure 5. Tensile strength of naturally faded denim fabric (Warp Yarn).

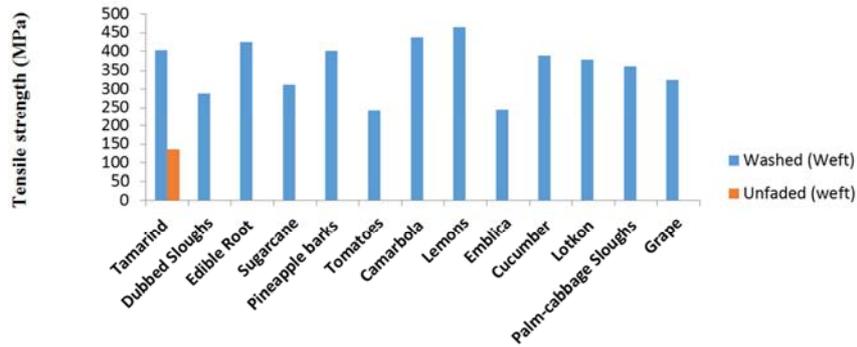


Figure 6. Tensile strength of naturally faded denim fabric (Weft Yarn).

From Table 3 it was seen that due to chemical fading there was less strength in the weft direction compared with the warp direction.

Table 3. Tensile strength of chemically faded denim fabric.

Chemical wash	Unfaded sample		Chemical Washed sample	
	Warp Tensile strength (MPa)	Weft Tensile strength (MPa)	Warp Tensile strength (MPa)	Weft Tensile strength (MPa)
Enzyme with stone			507.4	417.2
Enzyme Without stone			509.5	421.3
Only stone	161	135	505.2	419.3
Laser			497.7	411.2
Desizing			502.6	415.7

4.5. Fabric Stiffness of Naturally and Chemically Faded Denim Fabric

In natural fading in warp direction, Cucumber, Lotkon, Tomatoes and Carambola resulted in better stiffness value (Table 4). Among them Cucumber provided the best result whereas the others provided deviation stiffness value. Again in weft direction almost all provided better result. Among them Carambola, Tomatoes and Edible Root provided the best results (Table 4).

Table 4. Fabric Stiffness of naturally faded denim fabric.

Natural wash	Unfaded Sample		Washed sample	
	Warp	Weft	Warp	Weft
Tamarind			3.6	2.2
Dubbed Sloughs			3.0	2.2
Edible Root			3.3	2.5
Sugarcane			3.7	2.3
Pineapple barks			3.6	2.0
Tomatoes	3.1	2.0	3.8	2.4
Camarbola			3.8	2.6
Lemons			3.6	2.2
Emblica			3.5	2.2
Cucumber			4.0	2.2
Lotkon			3.9	2.0
Palm-cabbage Sloughs			3.5	2.2
Grape			3.5	2.3

In warp direction, the best result was found by chemically faded denim fabric with enzyme with stone, with only stone, and de-sizing (Table 5). The rest of the two samples provided deviation stiffness value. In weft direction, fading with stone and de-sizing provided the best result. The others provided the deviation stiffness value (Table 5).

Table 5. Fabric Stiffness of chemically faded denim fabric.

Chemical wash	Unfaded Sample		Washed Sample	
	Warp	Weft	Warp	Weft
Enzyme with stone			3.4	2.5
Enzyme Without stone			3.1	2.2
Only stone	3.1	2.0	3.4	2.4
Laser			3.6	2.3
Desizing			3.3	2.6

4.6. GSM of Naturally and Chemically Faded Denim Fabric

From the Figure 7 it was seen that comparison of GSM value of different washed sample and unfaded sample. Better GSM values for natural fading found from Lotcon, Emblica and Pineapple Barks.

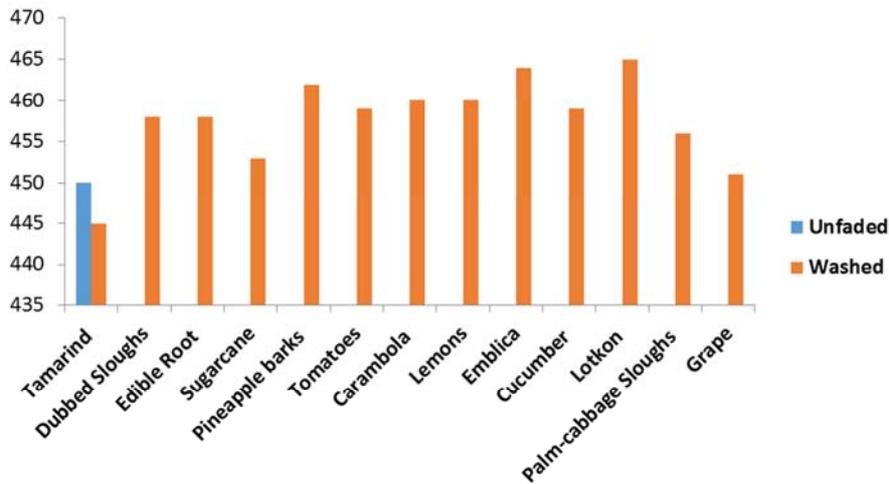


Figure 7. GSM of naturally faded denim fabric.

Among them Lotcon provided the best GSM value compared to the other sample. It may be because of shrinkage due to washing. There was lower change in GSM of chemical fading than that of natural fading (Figure 8)

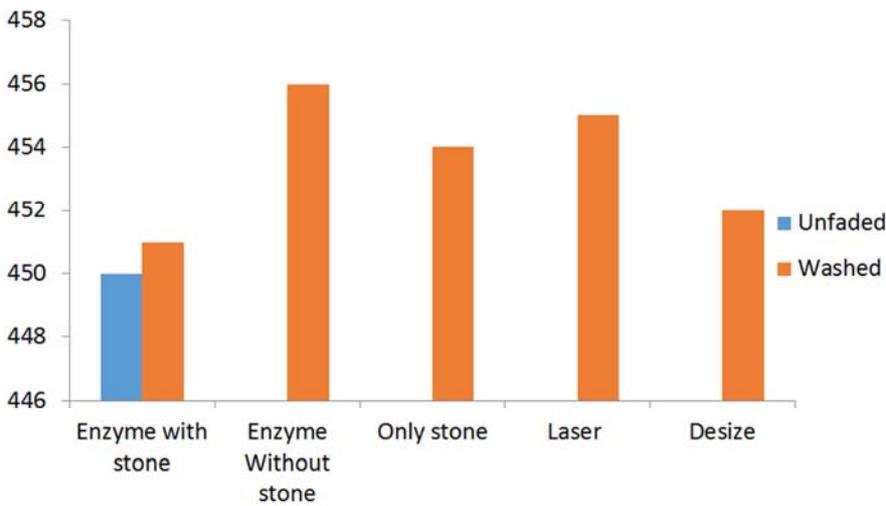


Figure 8. GSM of chemically faded denim fabric.

5. Conclusion

The discoloration of denim clothes by means of the use of natural reducing agent provide them self-identification and consequently upload value for the final client. These decreased water techniques are those that could acquire a washed look and super handle the use of a minimal quantity of water. The integration of such technologies into the chemical washing lines will ensure that antique looks and other style outcomes may be created on jeans with a good deal that required less water. In such cases, the effluent output is decreased to a negligible quantity, therefore transforming denim washing to an environmentally friendly process.

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