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Effects of Different Enzyme Wash on Properties of Denim Fabric

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Abstract
This paper is aimed at developing a method to analyze and compare the denim fabric properties after different enzymetic wash. To complete this research work, denim fabric (99% cotton, 1% Elastane) was treated with 3 different enzymatic wash (enzyme wash, medium enzyme bleach wash, light enzyme bleach wash). Enzyme chemicals (acidic enzyme or neutral enzyme) are basically used for Enzyme washing process . According to the wash reference, a bleaching process is needed to match the desired shade and it is done by using bleaching chemicals (KCl or Japanese bleach). Different properties of enzymatic fabric were tested i.e. rubbing fastness, wash fastness, stiffness, crease recovery and tear strength of fabric. Samples washed with above method have showed superior rubbing fastness and wash fastness. Also decrease in stiffness means the softness of washed fabric increases; and the crease recovery and the tear strength of denim fabric have increased.

Keywords: Denim Fabric, Enzyme Wash, Tear Strength, Crease Recovery, Wash Fastness, Rubbing Fastness.

1. Introduction
The current aim of this paper is to evaluate the properties of denim fabric incorporated with different enzyme wash. Washing is one of the principal and essentially utilized finishing techniques on cloth or apparel. Various kinds of washing strategies are frequently utilized in case of denim fabric finishing. To understand the specific outlook and additionally on changing the style, the remarkable washing techniques are stone wash, sand wash and bleach wash. Denim produced from the cloth with twill such as warp yarns are dyed with indigo colour and undyed or white weft yarns. In recent years, there may have been activity in the use of completely biodegradable enzymes which are environmentally pleasant and non-hazardous in the modern-day cloth ending process range of mechanical and chemical strategies which are regularly changed by the usage of enzymatic treatments, which are utilized to decorate high-quality material and comport. Within the material enterprise enzymes are basically utilized to urge a cleaner material floor with less fuzz, to scale the lower back tendency to pill formation, to smooth the surface combining with the usual softeners [1]. To decorate the material deal with other treasured properties, softeners are extensively used in the finishing operations [2]. During buying a textile, a fantastic and attractive handle of materials are extraordinarily and frequently regarded as the most fundamental criterion. Fabric handling with are frequently influenced through the use of softener which is analyzed within this research work [3]. In recent years some papers are published to analyze the exchange of textile's colors after using them of in numerous ending techniques as customers when deciding on an object from the store constantly listen to its coloration [4-5]. Fabric specification (ends/inch, picks/inch, surface density, warp & weft linear density), cloth wash fastness, material stiffness, tear strength, and many others ought to be dealt with as essential traits as these decide the putting on of sturdiness and longevity. However, the consequences of enzyme wash on the modifica-

tions of the above stated traits are in reality evaluated within this paper.

In this work, an attempt was made to investigate the effects of wash as well as to observe the denim fabric properties after different enzymatic wash. Denim fabric being washed with three enzymatic wash such as enzyme wash, medium enzyme bleach wash and light enzyme bleach wash. From color fastness to rubbing and wash, Stiffness, Crease recovery and tear strength of fabric were evaluated after the enzyme wash. It was found that rubbing fastness and wash fastness increase sequentially, also decrease in stiffness means softness of washed fabric increases, besides this the crease recovery and the tear strength of denim fabric are increased.

2. Materials and Methods

2.1 Fabrics

Denim fabric with following (Table 1) specification was taken to complete this research work. This fabric was collected from "RANKA DENIM TEXTILE MILLS LTD", Tongi, Gazipur.

Table 1. Fabric specification

Fabric type	Construction	Weave	Weight
(99% cotton,1% Elastane) Woven	($7^{RSL} \times 12^{L}$ 40^{D}) / (71×48)	3/1 RHT	11.25 oz

2.2. Instruments

Pipette, dryer, scissor, beaker, electric balance, washing machine, , crock meter and fabric strength tester were used during this research work.

2.3. Chemicals

The following chemicals were collected from "RANKA DENIM TEXTILE MILLS LTD", Tongi, Gazipur. Enzyme, Alkali (soda ash-Na2CO3 and caustic soda NaOH), acetic acid (100%).

2.4. Procedure for enzyme wash

The required chemicals and process sequence are summarized in Table 2 for enzyme wash.

Sequence	Process	Recipe and other operation (chemicals used in g/L)
First	De-sizing	Desizing Agent =0.6 Detergent = 0.8, M :L – 1:9, Temperature 60^0 C, Time 20 minutes, then wash by cold water
Second	Enzyme	Enzyme =2, Anti back staining agent =0.6 Acetic acid =0.6, M :L – 1:8, Temperature 45^0 C, Time 40-60 minutes, to kill enzyme, increase temperature 90^0 C for 1 minute, then rinse 2 times (each 3 minutes)
Third	Softening	Acetic acid = 0.6, cationic softener =1, M :L – 1:8, Room Temperature, Time 15 minutes
Fourth	Hydro extractor	This machine was used to remove excess water from washed fabric
Fifth	Drying	Drying was done at temperature 75^0 C for 40 minutes

Table 2. Procedure for enzyme wash.

2.5. Procedure for medium enzyme bleach wash

The required chemicals and process sequence are summarized in Table 3 for medium enzyme bleach wash.

Table 3. Procedure for medium enzyme bleach wash.

Sequence	Process	Recipe and other operation (chemicals used in g/L)
First	De-sizing	Desizing Agent =0.6, Detergent = 0.8, M :L – 1:9, Temperature 60^0 C, Time 20 minutes, then wash by cold water
Second	Enzyme	Enzyme =2, Anti back staining agent =0.6 Acetic acid =0.6 , M :L – 1:8, Temperature 45^0 C, Time 40-60 minutes, to kill enzyme increase temperature 90^0 C for 1 minute, then rinse 2 times (each 3 minutes)
Third	Bleaching	Chlorine bleach (kcl) =20, Sodium bi carbonate =4 , M :L – 1:7, Temperature 60^0 C, Time 20 minutes, then Rinse Twice, each for 3 minutes
Fourth	Treatment	Sodium hypo sulphite 2, Detergent 0.5 , M :L – 1:10, Temperature 50^0 C, Time 10-15 minutes, then Rinse Twice, each for 3 minutes
Fifth	Softening	Acetic acid = 0.6 , cationic softener =1, M :L – 1:8, Room Temperature, Time 15 minutes
Sixth	Hydro extractor	This machine was used to remove excess water from washed fabric
Seventh	Drying	Drying was done at temperature 75^0 C to 80^0 C for 40 minutes

2.6. Procedure for light enzyme bleach wash

The required chemicals and process sequence are summarized in Table 4 for light enzyme bleach wash.

Table 4. Procedure for light enzyme bleach wash.

Sequence	Process	Recipe and other operation(chemicals used in g/L)
First	De-sizing	Desizing Agent =0.6 , Detergent = 0.8 , M :L – 1:9, Temperature 60^0 C, Time 15 minutes, then wash by cold water
Second	Enzyme	Enzyme =2, Anti back staining agent =0.6 Acetic acid =0.6 , M :L – 1:8, Temperature 45^0 C, Time 40-60 minutes, to kill enzyme increase temperature 90^0 C for 1 minute, then rinse 2 times (each 3 minutes)
Third	Bleaching	Chlorine bleach (kcl) =20, Sodium bi carbonate =4 , M :L – 1:7, Temperature 60^0 C, Time 20 minutes, then Rinse Twice, each for 3 minutes
Fourth	Treatment	Sodium hypo sulphite2, Detergent 0.5 , M :L – 1:10, Temperature 50^0 C, Time 15 minutes, then Rinse Twice, each for 3 minutes
Fifth	Bleaching-2	Hydrogen peroxide = 4, Caustic soda = 1, Detergent 1 , M :L – 1:8, Temperature 60^0 C, Time 10 minutes, then Rinse Twice, each for 3 minutes
Sixth	Softening	Acetic acid = 0.6 , cationic softener =1, M :L – 1:8, Room Temperature, Time 15 minutes
Seventh	Hydro extractor	This machine was used to remove excess water from washed fabric
Eighth	Drying	Drying was done at temperature 75^0 C to 80^0 C for 40 minutes

2.7 Assessment of sample wash fastness

ISO standards 105-C03 method was followed for the measurement of color fastness to wash [8]. A sample of 10 × 4 cm was taken including a multi-fiber cloth strip. A washing solution containing 4 g/L detergent was once made between the laboratory dyeing machine with a liquor ratio of 1:50 the sample was once dealt for 30 minutes at 60±2 C (140±3.6 F). The sample was after used removal yet rinsed in regular water and dried among shadow. The exchange in color with degree of staining was evaluated visually. The usage of geometric grey scale summarized in Table 5. This evaluation was once performed in a color matching cabinet under standard lighting about D65 (artificial age light).

2.8 Assessment of color fastness to rubbing

For the measurement of rubbing fastness, ISO standards 105-X12 method was followed [9]. A specimen 14cm × 5cm was taken (one warp direction and other one weft direction). Then place the sample on the base of the crock meter and lock the test specimen, set 5cm × 5cm of the white cotton fabric to the upper finger of the crock meter. Then lower the covered finger on the test sample. Turn hand crank at the rate of the one turn per second and complete 10 turns. Remove the white rubbing test cloth and evaluate with grey scale. The output of this test result was given in Table 6.

2.9 Assessment of fabric stiffness

A stiffness tester was used to measure the fabric stiffness [10]. To conduct this test, a sample was taken (size 6 inch. X 1 inch.). Then both the template and swatch were transferred to the platform with the cloth underneath. Now each of them are gently pushed forward. The strip of the fabric would commence to droop over the edge of the platform and the movement of the template and the fabric were continued until the tip of the sample was considered among the reflect cuts of each index lines. The bending length could immediately be read off from the scale marked of opposite a zero line engraved about the aspect of regarding the platform. Each sample was examined 4 times, at every end and once more with the range became over. In that way three samples were tested. Finally mean values because of the bending length within warp and weft directions were calculated and given in Table 7.

Table 5. Effects of wash on color fastness to wash.

Sample Name	Color staining						Color change
	Diacetate	Cotton	Polyamide	Polyester	Acrylic	Wool	
Raw Sample (RS)	3	¾	4	4	¾	3	3/4
Enzyme wash (EW)	¾	4/5	4/5	4	4	¾	4
Medium enzyme bleach wash (MEBW)	3	¾	4	4	¾	3	4
Light enzyme Bleach wash (LEBW)	¾	4/5	4	4	4/5	4	4/5

Table 6. Effects of enzyme wash on color fastness to rubbing.

Sample Name	**Dry**	**Wet**
Raw sample (RS)	4	½
Enzyme wash (EW)	4/5	2/3
Medium enzyme bleach wash (MEBW)	4	2/3
Light enzyme bleach wash (LEBW)	4/5	3

Table 7. Results of enzyme wash on fabric stiffness.

Sample Name	Warp	Weft
Raw Sample (RS)	8.4cms	5.4cms
Enzyme wash (EW)	7.7cms	4.5cms
Medium Enzyme bleach wash (MEBW)	7.5cms	4.3cms
Light enzyme Bleach wash (LEBW)	7.5cms	4.3cms

2.10 Measurement of crease recovery

The wrinkle recovery tester scale: 00-1800 was used to carry out this test [11].The crease was applied on partly folded material by placing it among two glass plates or including it in accordance with a 500gm weight over it. After 1 min the weight is removed and then the creased cloth was clamped in regarding the instrument. Then it was allowed for crease recovery, the recovery time may vary, usually it is 1 min. As soon as the crease recovered the instrument dial is rotated to keep the free edge of the specimen in line with the knife edge. The recovery angle was taken from the engraved scale. In that access ten assessments had been made into warp way and then ten for weft way. Then mean value regarding recovery angle was done (Table 8).

Table 8. Effects of different wash on Crease recove

Sample Name	Warp recovery angle	Weft recovery angle
Raw sample (RS)	51^0	37^0
Enzyme wash (EW)	83^0	64^0
Medium enzyme bleach wash (MEBW)	107^0	71^0
Light enzyme bleach wash (LEBW)	83^0	59^0

2.11 Measurement of fabric tear strength

The shirley tear strength tester was used to complete this test [12]. Before starting this test warp and weft directions of the fabric were used to be identified. Two strips were cut from the sample fabric in both directions at the dimensions of 100 mm x 63.5 mm. The sample was then fixed within the jaws of the tearing tester. A cut of about 20mm was once made alongside the width of the cloth using the cutter in the tearing tester. By the use of the falling pendulum of the tearing tester the material used to break and the readings had been noted (Table 9).

Table 9. Effects of different wash on tear strength.

Sample Name	Warp	Weft
Raw Sample (RS)	51N	28N
Enzyme wash (EW)	39N	21N
Medium Enzyme bleach wash (MEBW)	44N	26N
Light enzyme Bleach wash (LEBW)	42N	23N

3. Results and Discussion

The effects of different wash on denim fabric properties are sequentially discussed below.

3.1. Effects of different wash on color fastness to wash

The effects of different enzyme wash on color fastness to wash are shown in the Table 5 and Figure 1. From this table and figure, it is found that the softening imparts considerable (increase fastness) changes on the denim fabric wash fastness [7]. Among three washes medium enzyme bleach wash and light enzyme bleach wash showed better wash fastness than the raw sample and the enzyme wash sample.

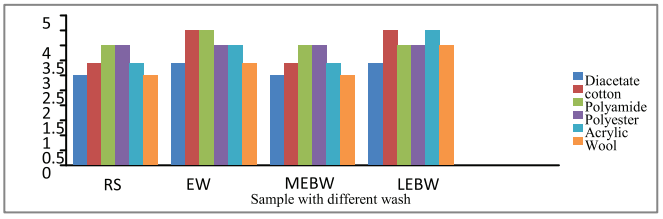

Figure 1. Effects of different wash on color fastness to wash.

3.2. Effects of different wash on color fastness to rubbing

The effects of enzyme wash on rubbing are shown in the Table 6 and Figure 2. It is clear that the rubbing fastness increases than the raw sample for both dry and wet condition, but dry rubbing is better than wet rubbing [6]. Among the entire wash light enzyme bleach wash showed the better result than the other washes.

3.3. Effects of different wash on fabric stiffness:

Table 7 and Figure 3 show the fabric stiffness along with the warp and weft directions. It is understandable that afterwards the enzymatic washing process, stiffness of tested fabric (both warp and weft direction) had been decreased which indicated the softness of the fabric increase [7]. It was also observed that among three washes the medium enzyme bleach wash and the light enzyme bleach wash showed the better result than the enzyme wash.

3.4 Effects of different wash on crease recovery:

The effects of different wash on crease recovery was shown in Table 8 and Figure 4. The warp recovery angle is better than weft recovery angle for all wash which means that crease resistant property of washed sample increases. Among all the washes medium enzyme bleach wash showed the better result than the other washes.

3.5. Effects of different wash on Tear strength

Table 9 and Figure 5 show the fabric tear strength along with the warp and weft directions. It is seen that after the enzymatic washing process, tear strength of the tested fabric (both warp and weft direction) has had been decreased which indicated the strength of the fabric decreased [7].

3.6. Tested samples

The following figures are given for different wash effects such as raw sample, enzyme wash, medium enzyme bleach wash and light enzyme bleach wash respectively.

It was intended to observe the effects of different enzyme wash concerning denim fabric characteristics. For that purpose a number of denim pants were selected as apparel and after washing, a considerable change on the properties of denim pants has been observed. Although we wanted to see other parameters of denim fabric with another wash but due to this pandemic situation it was not possible to extend this research work. Finally it is concluded that the stiffness of tested fabric has been decreased which indicates softness of fabric increases. Fastness properties like as color fastness to rubbing and color fastness to wash has been increased. To hold the qualities of denim fabric it is very important to observe the effects of enzyme wash on denim apparels. By this paper it will be possible to know how denim fabrics characteristics can be changed by enzyme wash.

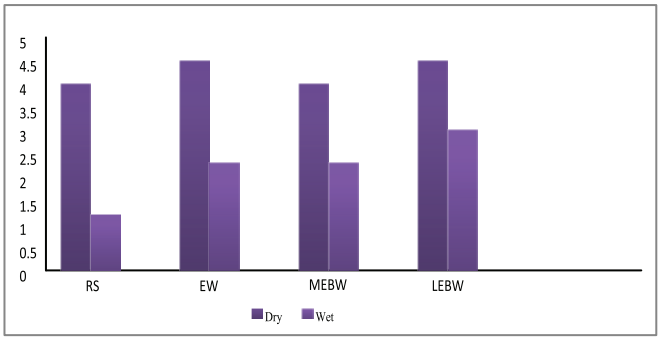

Figure 2. Effects of different wash on color fastness to rubbing.

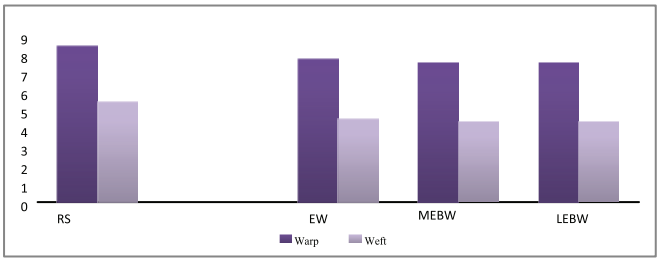

Figure 3. Effects of different wash on fabric stiffness.

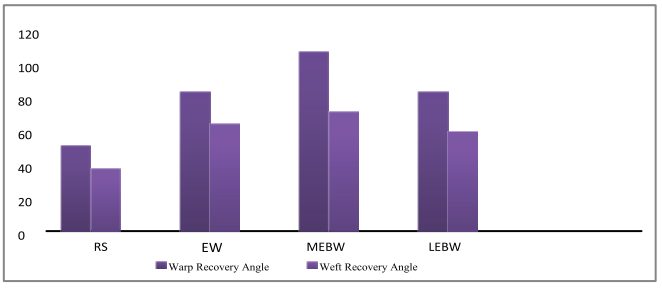

Figure 4. Effects of different wash on crease recovery.

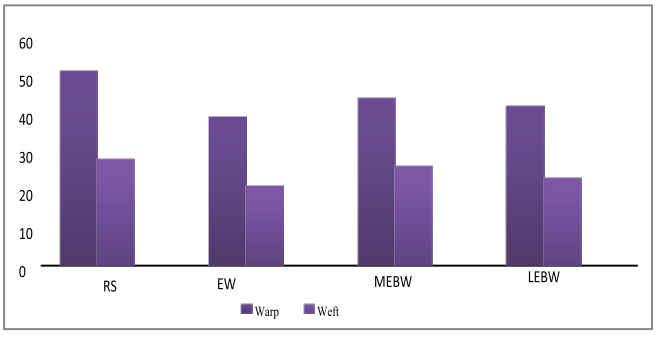

Figure 5. Effects of different wash on tear strength.

Figure 6. Raw sample.

Figure 7. Enzyme washed sample.

Figure 8. Medium enzyme bleach. washed sample.

Figure 9. Light enzyme bleach washed sample.

4. Conclusion

It was intended to observe the effects of different enzyme wash concerning denim fabric characteristics. For that purpose a number of denim pants were selected as apparel and after washing, a considerable change on the properties of denim pants has been observed. Although we wanted to see other parameters of denim fabric with another wash but due to this pandemic situation it was not possible to extend this research work. Finally it is concluded that Stiffness of tested fabric has been decreased which indicates softness of fabric increases. Fastness properties like as colour fastness to rubbing and colour fastness to wash has been increased. To hold the qualities of denim fabric it is very important to observe the effects of enzyme wash on denim apparels. By this paper it will be possible to know how denim fabrics characteristics can be changed by enzyme wash.

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