

## AN ANALYSIS ON THE EFFECTS OF DIFFERENT TYPES OF ENZYME WASHING ON THE PHYSICO-MECHANICAL PROPERTIES OF DENIM GARMENTS

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**Abstract-** Denim washing is an aesthetic finish given to denim fabric. Enzyme reaction is controllable and its biodegradable products are eco-friendly. In this study, Enzyme washing is done on 27 samples. Various shading effect can be derived from enzyme washing. Along with shade variation, concentration and type variation (powder/ liquid / both) of enzyme gives changes in properties. We have examined 5 properties which are count, GSM, Stiffness, Strength and shrinkage. Desizing and use of stone create changes in properties of denim garments specially in GSM. Count is lower in powder washing than liquid washing. Warp way shrinkage is more than weft way shrinkage after washing. Stiffness is less in warp direction (face side than back side) which is contrast to the weft direction, more in liquid than powder washing and less in stone washing. Strength is lower in weft direction, reduces in stone washing and more in undesized sample.

Keywords: Denim, Enzyme, Gram per Square Meter (GSM), eco-friendly, desizing.

### 1. INTRODUCTION

Nowadays Enzyme wash on Denim garments has become very popular. It is found that most of the denim garments are washed through enzyme washing process. As Enzyme is eco-friendly and it can give various fading effects. Hence, its popularity is even more increasing. It is natural that after washing the properties of the garments changes. Although the changes are not high, the changes are important for understanding the future performance of the garments. Advance garments Technology studies on washing effects and changes of properties of garments. This project on the effects of enzyme wash on Denim garments is a part of practical knowing of the effects of enzyme washing on denim garments. Along with shade variation, the concentration variation of enzyme, the type variation of enzyme like powder or liquid or combination of both give changes in properties. It is also noticed that Desizing and stone wash also create changes in properties of denim garments.

### 2. MATERIAL AND METHODS

#### 2.1 Materials

Denim garments (leg panels) are collected from Apparel manufacturing laboratory in Khulna University of Engineering and Technology. 100% Cotton twill (3/1) has construction: 72\*41/9\*9. Black yarn in warp way (combination shade) and white yarn in weft way. Liquid

enzyme (Genzyme 200), powder enzyme (Bactosol) and Pumic stone were collected from sepal group & HAMS Washing & Dyeing limited. Garments were enzyme washed using the standard recipe.

#### 2.2 Washing Condition

No. of the sample	: 27
M:L	: 1:10
Material weight	: 350 gm
Enzyme concentration (Bactosol)	: 1 g/l, 1.5 g/l
Enzyme concentration (Genzyme)	: 1 g/l, 1.5 g/l
Enzyme concentration (Bactosol+ Genzyme)	: 1 g/l, 1.5 g/l
Pumic stone	: 1.5g/l
Temperature	: 45°C(fixed)
Time	: 30 min.

#### 2.3 Procedure of Washing

##### 2.3.1 Desizing Process

Process sequence of Desizing:

- Sample
- Addition of water
- Machine Run
- Addition of Desizing Agent
- Addition of Anti-black Staining Agent
- 15 min M/C run
- Rinse 2 time

### 2.3.2 Enzyme Washing Process

Process sequence of Enzyme Wash:

- Sample
- Addition of water
- Machine Run
- Addition of Enzyme
- Addition of Acetic Acid
- Addition of Anti Back Staining Agent
- Machine Run 30 min
- Neutralization
- Rinse 2 time

### 2.3.3 Hydro-extracting

Process sequence of Hydro extracting :

- Sample
- Machine Run for 1.5min – 2min

### 2.3.4 Drying

Process sequence of Drying :

- Sample
- Temp 80°C
- Machine Run for 30 min – 45 min

## 2.4 Identification of Sample

**Sample 1:** Raw sample (Without desizing and washing)

**Sample 2:** Desized and washed with liquid enzyme without stone (enzyme conc. :1g/l).

**Sample 3:** Undesized and washed with liquid enzyme without stone (enzyme conc. :1g/l).

**Sample 4:** Desized and washed with liquid enzyme with stone (enzyme conc. :1g/l).

**Sample 5:** Undesized and washed with liquid enzyme with stone (enzyme conc. :1g/l).

**Sample 6:** Undesized and washed with liquid and powder enzyme without stone (enzyme conc. :1g/l).

**Sample 7:** Desized and washed with liquid and powder enzyme without stone (enzyme conc. :1g/l).

**Sample 8:** Undesized and washed with liquid and powder enzyme with stone (enzyme conc. :1g/l).

**Sample 9:** Desized and washed with liquid and powder enzyme with stone (enzyme conc. :1g/l).

**Sample 10:** Desized and washed with powder enzyme with stone (enzyme conc. :1g/l).

**Sample 11:** Undesized and washed with powder enzyme with stone (enzyme conc. :1g/l).

**Sample 12:** Desized and washed with powder enzyme without stone (enzyme conc. :1g/l).

**Sample 13:** Undesized and washed with powder enzyme without stone (enzyme conc. :1g/l).

**Sample 14:** Only desized sample.

**Sample 15:** Desized and washed with powder enzyme without stone. (enzyme conc. :1.5g/l).

**Sample 16:** Undesized and washed with powder enzyme without stone (enzyme conc. :1.5g/l).

**Sample 17:** Undesized and washed with Liquid enzyme with stone (enzyme conc. :1.5g/l).

**Sample 18:** Desized and washed with Liquid and Powder enzyme without stone (enzyme conc. :1.5g/l).

**Sample 19:** Undesized and washed with Liquid and powder enzyme without stone (enzyme conc. :1.5g/l).

**Sample 20:** Undesized and washed with Liquid and Powder enzyme with stone (enzyme conc. :1.5g/l).

**Sample 21:** Desized and washed with Powder enzyme with stone (enzyme conc. :1.5g/l).

**Sample 22:** Undesized and washed with Powder enzyme with stone (enzyme conc. :1.5g/l).

**Sample 23:** Desized and washed with Powder and Liquid enzyme with stone (enzyme conc. :1.5g/l).

**Sample 24:** Desized and washed with Liquid enzyme with stone (enzyme conc. :1.5g/l).

**Sample 25:** Only desized sample.

**Sample 26:** Undesized and washed with Liquid enzyme without stone (enzyme conc. :1.5g/l).

**Sample 27:** Desized and washed with Liquid enzyme without stone (enzyme conc. :1.5g/l).

## 3. RESULT AND DISCUSSION

### 3.1 The Experimental Data

According to two different enzyme concentration which is 1.0 g/l and 1.5 g/l, two tables have been prepared to represent the five major test, (gram per square meter), count, shrinkage, stiffness, strength.

### 3.2 Test Parameter Analysis

#### 3.2.1 GSM (gram per square meter) Measurement

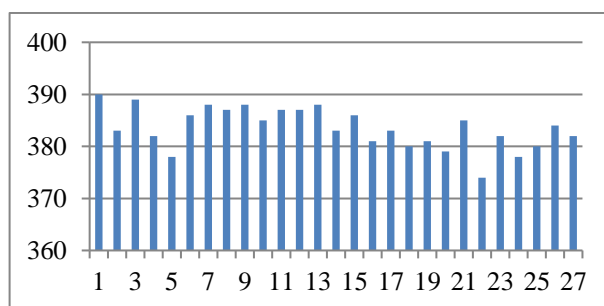


Fig 1: graph for GSM

In figure 1, X-axis indicates the sample Number while in Y-axis, the GSM range has been showed.

Here, GSM is higher for desized sample while washing with liquid enzyme and vice versa. GSM is lower while washing with stone.

Table 1 indicates the data of different tests parameters (GSM, count, shrinkage, stiffness, strength) of sample 1 to 14 for enzyme concentration 1 g/l.

Table 2 is for the same five major test, (gram per square inch), count, shrinkage, stiffness, strength of sample 15 to 27 having concentration 1.5 g/l.

Table 1: Effect of different types of enzyme washing at Enzyme conc.:1.0 g/l on the characteristics (physical and mechanical properties) of denim garments

Sample No.	GSM	Count(Ne)		Shrinkage(inch)						Stiffness(bending length in cm)				Strength(lb)	
		Warp	Weft	Warp direction			Weft direction			Warp		Weft		Warp	Weft
				Before wash	After wash	Shrinkage %	Before wash	After wash	Shrinkage %	Face Side	Back side	Face side	Back side		
01	390	9	9	10	—	—	—	—	—	3.88	3.7	2.33	2.73	350	180
02	383	10	9	10	9.85	3.5	10	10	0	3.6	2.79	2.35	2.68	409	200
03	389	9	8	10	9.6	4	10	10	0	3.4	2.78	2.33	2.65	251	310
04	382	11	9	10	9.2	8	10	9.85	1.5	3.38	2.53	2.28	2.58	320	150
05	378	10	7	10	9.75	2.5	10	10	0	3.25	2.68	2.33	2.68	320	270
06	386	9	8	10	9.7	3	10	9.95	0.5	3.28	2.68	2.2	2.55	110	180
07	388	9	8	10	9.75	2.5	10	10	0	3.25	2.65	2.22	2.67	220	310
08	387	10	9	10	9.1	9	10	9.75	2.5	3.28	2.68	2.2	2.63	280	370
09	388	10	9	10	9.85	1.5	10	9.95	0.5	3.23	2.63	2.25	2.68	430	330
10	385	10	9	10	9.7	3	10	10	0	3.28	2.65	2.3	2.6	270	150
11	387	10	9	10	9.5	5	10	9.95	0.5	3.25	2.65	2.2	2.68	330	350
12	387	9	8	10	9.7	3	10	9.95	0.5	3.28	2.63	2.25	2.63	320	310
13	388	9	8	10	9.8	2	10	10	0	3.3	2.68	2.23	2.65	360	340

Table 2: Effect of different types of enzyme washing at Enzyme conc.:1.5g/l on the characteristics (physical and mechanical properties) of denim garments

Sample No	GSM	Count(Ne)		Shrinkage(inch)						Stiffness(bending length in cm)				Strength(lb)	
		Warp	Weft	Warp direction			Weft direction			Warp		Weft		Warp	Weft
				Before wash	After wash	Shrinkage %	Before wash	After wash	Shrinkage %	Face side	Back side	Face side	Back side		
14	383	10	8	10	9.75	2.5	10	10	0	3.28	2.75	2.4	2.55	380	320
15	386	10	7	10	9.5	5	10	9.9	1	3.22	2.58	2.35	2.78	320	290
16	381	9	8	10	9.85	1.5	10	10	0	3.25	2.65	2.3	2.63	330	220
17	383	10	8	10	9.8	2	10	10	0	3.28	2.62	2.33	2.58	450	310
18	380	9	8	10	9.75	2.5	10	9.9	1	3.13	2.65	2.28	2.63	330	190
19	381	9	8	10	9.7	3	10	10	0	3.33	2.55	2.2	2.6	460	220
20	379	10	8	10	9.6	4	10	10	0	3.13	2.6	2.35	2.7	410	250
21	385	10	8	10	9.7	3	10	9.9	1	3.28	2.65	2.33	2.73	330	210
22	374	10	9	10	9.7	3	10	10	0	3.23	2.73	2.3	2.73	500	340
23	382	9	8	10	9.65	3.5	10	9.9	1	3.28	2.7	2.25	2.68	450	320
24	378	10	9	10	9.9	1	10	9.9	1	3.2	2.68	2.33	2.65	350	230
25	380	10	8	10	9.67	3.3	10	10	0	3.33	2.65	2.3	2.65	440	160
26	384	10	8	10	9.67	3.3	10	10	0	3.3	2.63	2.28	2.58	400	150
27	382	10	8	10	9.7	3	10	9.9	1					430	250

### 3.2.2 Count Measurement

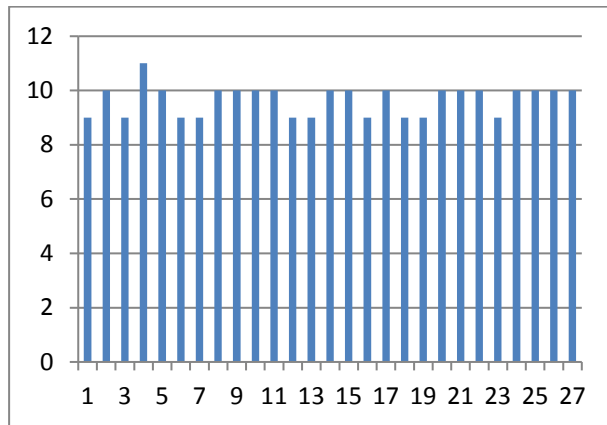


Fig. 2: Graph for warp count

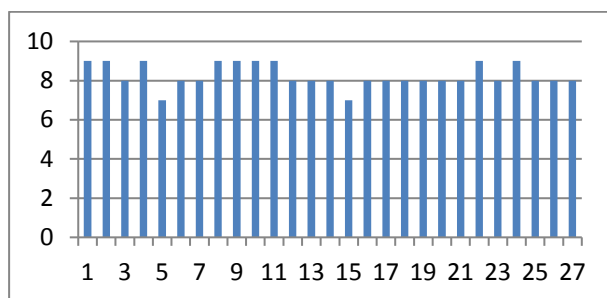


Fig. 3: Graph for weft count

In figure 2 and 3, X- axis indicates the samples Number and Y-axis indicates warp count in figure 2 while it is weft count for figure 3.

Here very small variation in count for different washing stone wash causes finer count. Count is lower in powder washing than liquid washing.

### 3.2.3 Shrinkage Test

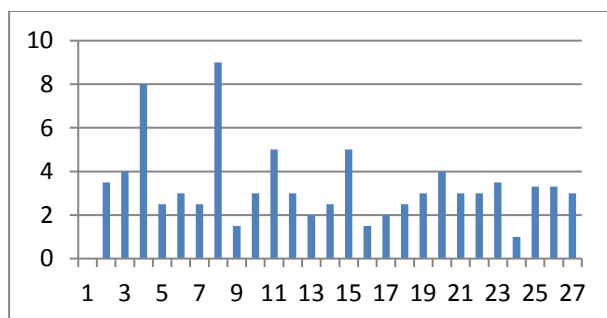


Fig. 4: graph for warp shrinkage

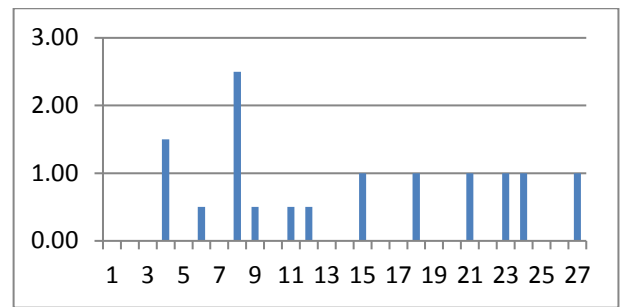


Fig. 5: graph for weft shrinkage

In figure 4 and 5, X- axis indicates the samples while the shrinkage range in percentage are represented in Y-axis. Figure 4 shows the result of warp wise shrinkage and figure 5 shows the shrinkage in weft direction. Here, shrinkage occurs in washing. Warp way shrinkage is more than weft way shrinkage. Stone washing causes more shrinkage.

### 3.2.4 Stiffness Test (bending length test)

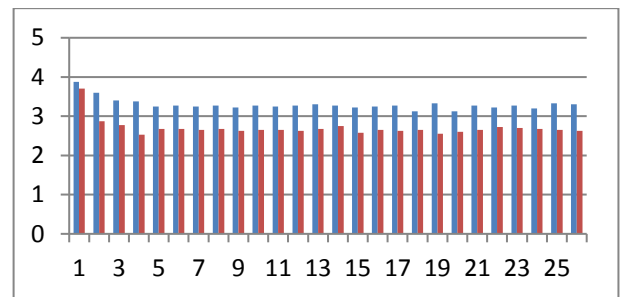


Fig. 6: Graph For Warp side Stiffness ■ - face side, ■ - back side

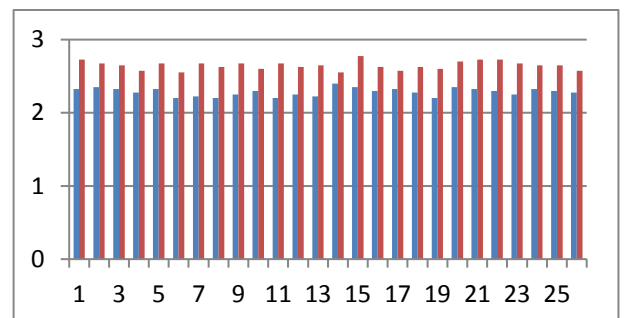


Fig. 7: Graph For Weft side Stiffness ■ - face side, ■ - Backside

In figure 6 and 7, X- axis indicates the samples and the range of bending length in cm is presented in Y-axis. The bending length test for both face side and back side represents the stiffness of the sample. The higher the bending length the stiffer is the fabric. Here figure 6 represents warp wise stiffness while figure 7 represents weft wise stiffness.

Here, in the warp direction face side has more bending length than back side. So in the warp direction face side has less stiffness than back side. On the other hand in the weft direction face side has less bending length than back

side. So in the weft direction back side has less stiffness than face side. Stiffness reduces after washing. Stiffness is more in liquid enzyme than powder enzyme. Stiffness is less in stone washing.

### 3.2.5 Strength Test

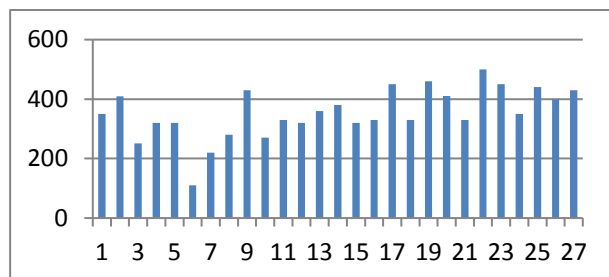


Fig 8: Graph for strength test (Warp wise)

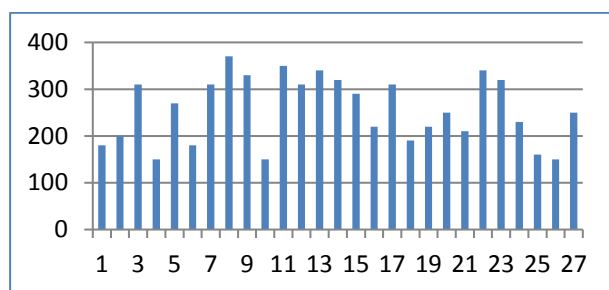


Fig 9: Graph for strength test weft wise

In figure 8 and 9, X- axis indicates the samples while Y-axis represents strength range in lb.

Washing causes a huge change in strength of garments. Strength has fluctuated randomly in different samples. Some samples has very low strength like no 6 which is desized with powder and liquid enzyme washed. Other samples shows acceptable strength in warp wise. In weft direction strength is lower than warp direction. Strength reduces in stone washing. Strength is more in undesized sample than desized sample.

## 4. CONCLUSION

We have done Enzyme washing focusing on liquid enzyme and powder enzyme particularly on samples with a little variations of recipe. And found difference in their properties. We have examined 5 properties they are GSM measurement, count measurement, shrinkage, Stiffness, Strength.

We found some differences which is for using different types of enzyme as well as for difference in recipe. There are some unacceptable errors which occur due to poor testing machine condition.

## 5. REFERENCES

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