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Comparison of enzyme & bleach washed knitted denim (Z Twill) treated with different amount of softening & anti-creasing agent

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Abstract

This work is aimed at giving emphasis on effect of finishing agents on washing of knitted denim fabric. The difference of properties after treating with finishing agents (Softening and Anti-creasing) of different amount on knitted denim was measured. After testes the result were significantly different among the samples. As it is observed that color fastness to wash was not affected highly but all other factor was affected, like the color fastness to rub, shrinkage percentage and weight. This was measured by comparing with the sample that was not treated with finishing agents.

Keywords: Knitted denim, Indigo, Finishing Agents, Washing.

INTRODUCTION

Denim is a sturdy twill textile in which the weft passes under two or more warp threads. Since the denim has great demand in the market at present and knitted fabrics are popular for their shape fitting properties, softer handle, comfortable nature and high extension at low tension, a new way of combining the two methods of fabric construction to create a "Denim effect using knit structures" has been effected so as to create value added product.

Denim garment washing is known as one of the widely used finishing treatment that has vast usage in textile sec-tors because of creating special appearance and making fashionable and wear comfortable garments. Also, popularity of garments washing specially on denim garments in the world market has been increasing day by day [1]. Among the washing methods, enzymatic method is widely used method in industry. However, enzyme treatment of cellulosic garments degrades cellulose at the ends or in the middle of the cellulose chains, yielding shorter chain cellulose polymers, and reduces its mechanical strength [2]. But cellulase treatments have been successful at improving fiber flexibility, desirable appearance and soft handle of cotton denim

garments [3]. And bleach method is also widely used method in industry especially for denim washing to achieve required color shade by hypochlorite bleaching [4]. That is why in this research finding the relationsbetween use of enzyme-bleach washing and finishing treatment was the main objective as both of this process are a must.

MATERIALS & METHODS

Materials

A 3/1 Z twill knitted denim fabric dyed with indigo dyes in deep blue shade was used for all the processes.

The samples taken from the fabric were 36 cm × 34 cm in size. Among which ten samples were treated with Belfasin GT cationic softener and Roleflex BZ anti-creasing agent. The acetic acid, cellulose enzyme, sodium carbonate, bleaching powder, and sodium hyposulfite was analytical grade.

Chemicals

- Cellulose enzyme
- Sodium Carbonate/Soda ash
- Detergent
- Wetting agent
- Bleaching powder
- Sodium Hyposulphite
- Acetic acid

Machineries

- Washing machine (Electrolux-WH6-6)
- Dryer machine (Electrolux-TD6-6)
- GSM cutter (SCHRODER)
- Crock meter (UTSTESTER)
- Weight balance (And-Gulf)

Methods

To conduct this research, we treated five samples with same amount of softening agent but different amount of anti-creasing agent and other five samples were treated with same amount of anti-creasing agent but different amount of softening agent. Concentrations of finishing auxiliaries are given in Table 1. Weonly kept one sample dyed but un-treated. All the samples were gone through same enzyme – bleach wash. Then we tested all the samples and compared the results see the variation.

Table 1: Concentrations of finishing auxiliaries according to sample no.

Sample Number	Concentration		
	Softening Agent (on the weight of fabric)	Anti-Creasing Agent (on the weight of fabric)	Acetic Agent (g/l)
1	2%	2%	2
2	3%	2%	2
3	4%	2%	2
4	5%	2%	2
5	6%	2%	2
6	2%	2%	2
7	2%	3%	2
8	2%	4%	2
9	2%	5%	2
10	2%	6%	2

Washing Procedure

Process: Hot Wash → Enzyme Wash → Rinsing → Bleach Wash → Rinsing → Neutral Wash → Rinsing → Hydro-Extraction → Dryer [5].

Hot wash: M: L = 1: 10, temperature= 60°C, time=5 min.
Enzyme wash: M: L = 1: 10, pumice stone = ½ volume of samples, enzyme = 1.50 g/l, acetic acid = 0.6 g/l, temperature = 40°c to 50°c, time (Depend upon the shade) = 60 to 70 min.
Then temperature was raised to 90°c for 1 minute. The liquor was then dropped and the samples were rinsed twice, each time for 3 minutes. Then pumice stone was taken out from washing machine.
Bleach wash: M: L = 1: 10, bleaching powder = 10 g/l, sodium carbonate = 5 g /l, temperature = 60°c, time (Depend upon the shade) = 12 to 15 min,
The liquor was dropped and samples were rinsed twice, each time for 3 minutes.
Neutral wash: M: L = 1: 10, sodium hyposulfite = 3 g/l, temperature = 40°C, time = 10 to 12 min,
The liquor was dropped and samples were rinsed twice, each time for 3 minutes.
The samples were put into hydro-extracting machine to remove excess water from the washed garments.
Drying machine: Temperature = 75°C to 85°C, time = 35 to 40 min, Cold dry = 10 min.

Tests

All sample's physical properties like GSM, shrinkage and spirality as well as some chemical properties like color fastness to wash, color fastness to staining and color fastness to rubbing was measured.

Color Fastness to Wash

The resistance to the loss of color of any dyed or printed material during washing is referred to as its color fastness to wash. If dye molecule has not penetrated inside the inter polymer chain space of fiber with strong attractive force poor color fastness to wash result is found. Color fastness to wash test was carried as per ISO 105 C06 method.

Instruments:

- Gyro wash,
- Stainless still ball,
- Multi-fiber fabric,
- Grey scale &
- Light box.

Recipe:

Sodium Perborate……. 1 g/l
ECE Phosphate……. 4 g/l

Sample Preparation:

Sample fabric…….10 cm X 4 cm
Multi fiber fabric……10 cm X 4 cm

Procedure:

Specimen of 4 cm X 10 cm in size was made
↓
The specimen was attached with multi-fiber fabric of same 4 cm X 10 cm in size
↓
Solution of 4g/l ECE detergent & 1 g/l Sodium Perborate was made
↓
Specimen with multi-fiber fabric was added into the solution and put in the machine at temperature: 60℃ / 40℃ for 50 min with 25pcs still ball
↓
Rinsed with hot water
↓
Washed with cold water
↓
Air drying with temperature not exceeding 60℃
The staining was assessed by Grey staining scale.

Color Fastness to Rubbing

Color fastness to rubbing was designed to determine the degree of color which may be transferred to a specific pressure applied by crock meter. This test was done in both dry and wet state. The crocking cloth which is unbleached, undyed cotton fabric was rubbed against test sample for ten times. 100% pick-up for crocking cloth was maintained for wet rubbing. Color fastness to rubbing was tested by crock meter as per ISO105 X12:1992 method. After the test the degree of staining was assessed with Grey staining scale.

Shrinkage Percentage

Every sample when undergoes washing, most of the cases they change their dimension. In general sense the change in length or width of a fabric specimen subjected to a specific condition is known as dimensional changes. The dimensional changes resulting in an increase of length or width is called stretched condition and the dimensional changes result in decrease of length or width is called shrinkage.

At first all the samples were conditioned for 4 hours in a standard temperature & RH% and the length & width of the samples were measured before washing. After wash, again the length and width of the samples were measured for identification of the stretch or shrinkage%. To measure a square block of 25mm x 25mm was marked on the initial fabric and below formula was used.

$$\text{Shrinkage} = \frac{(\text{Original measurement} - \text{After wash measurement})}{\text{Original measurement}} \text{X100..(1)}$$

GSM Measurement

The term GSM of fabric means the weight of the fabric in grams per square meter (Weight per unit area). GSM is the most important parameter which is maintained in the factory or industry. It is maintained in the all stages in the processing of knit fabric. It is also measured after dyeing, before dyeing and every stages of finishing process. GSM was measured by GSM cutter. Here before wash GSM of all the samples were measured and after wash GSM of ten samples were measured for comparison.

RESULTS & DISCUSSION

Color Fastness to Wash

Table 2: After washing color fastness to wash rating of 1st – 5th samples.

Sample No	Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
Untreated	5	5	4.5	5	5	5
1	5	5	5	5	5	5
2	5	5	4.5	5	5	5
3	5	5	4.5	5	5	4.5
4	5	5	4.5	5	5	5
5	5	5	4.5	4.5	5	5

Table 3: After washing color fastness to wash rating of 6th – 10th samples.

Sample No	Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
Untreated	5	5	4.5	5	5	5
6	5	5	4.5	5	5	5
7	5	5	4	5	5	5
8	5	5	4.5	5	5	4.5
9	5	5	4.5	5	5	5
10	5	5	4.5	5	5	5

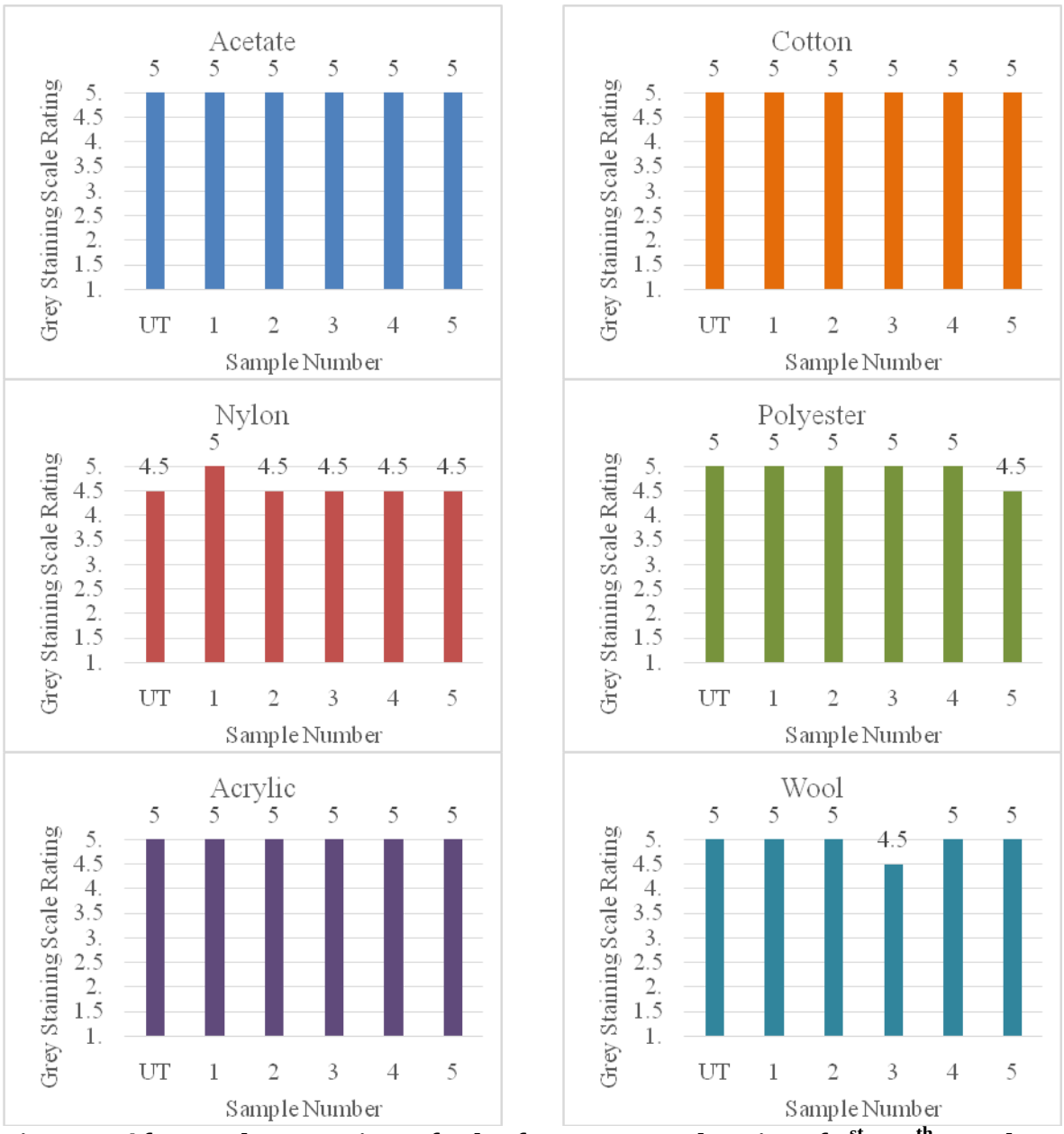

Figure 1: After wash comparison of color fastness to wash rating of 1st to 5th samples.

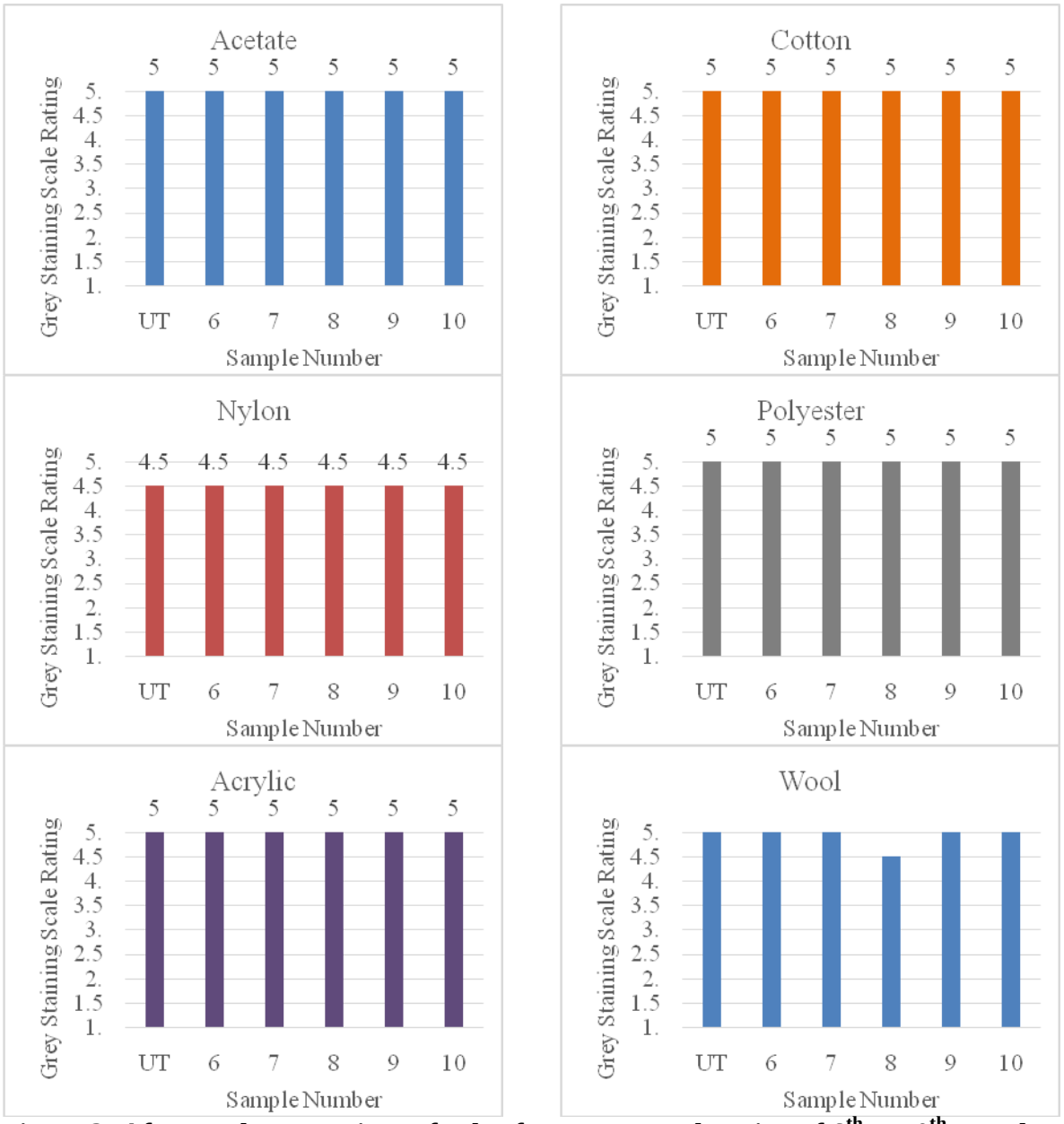

Figure 2: After wash comparison of color fastness to wash rating of 6th to 10th samples.

The after-wash samples were assessed in light box under D65 light with Grey staining scale for color fastness to wash rating. Indigo dyesshow a great level of color fastness to wash [5] as they are water insoluble in natural form and only become water soluble when they are reduced to Leuco form. So, the test specimen showed very less changes to color fastness to wash rating. Most of the fibers in multi-fiber fabric seems to have a "Good" wash fastness rating. Finishing agents did not affect the result much. Like, for sample 1st to 5th (anti-creasing amount was fixed (2%) with variable (2% - 6%) amount of softening agent) Grey staining scale rating was "Good (5)" for wool, acrylic, polyester, cotton and acetate. Though in this case nylon the ratings weredegraded from 5 to 4.5 for all the sample of this batch. But same result was

found in case of untreated sample as well. Some other fibers like wool and polyester also changed in some cases but that's negligible. Sample 6^{th} to 10^{th} (softening agent amount was fixed (2%) with variable (2% - 6%) amount of anti-creasing agent) Grey staining scale rating was "Good (5)" for wool, acrylic, polyester, cotton and acetate. But just like previous batch of variable amount of softening agent this batch also seems to lose the rating for nylon which become 4.5 in average. Color fastness to wash did not affect much for indigo with the changes of finishing agents amount as indigo (Vat dye) dyes have unparalleled level of fastness to wash.

Color Fastness to Rub

Table Error! No text of specified style in document.**: After washing color fastness to rub rating of 1st – 5th samples.**

Sample No	Dry Rubbing Test	Wet Rubbing Test
Untreated	4.5	2
1	4	2
2	4.5	2.5
3	4.5	1.5
4	4.5	2.5
5	4.5	2

Table 5: After washing color fastness to rub rating of 6th – 10th samples.

Sample No	Dry Rubbing Test	Wet Rubbing Test
Untreated	4.5	2
6	4.5	2
7	4.5	1.5
8	4.5	2
9	4.5	2
10	4	1.5

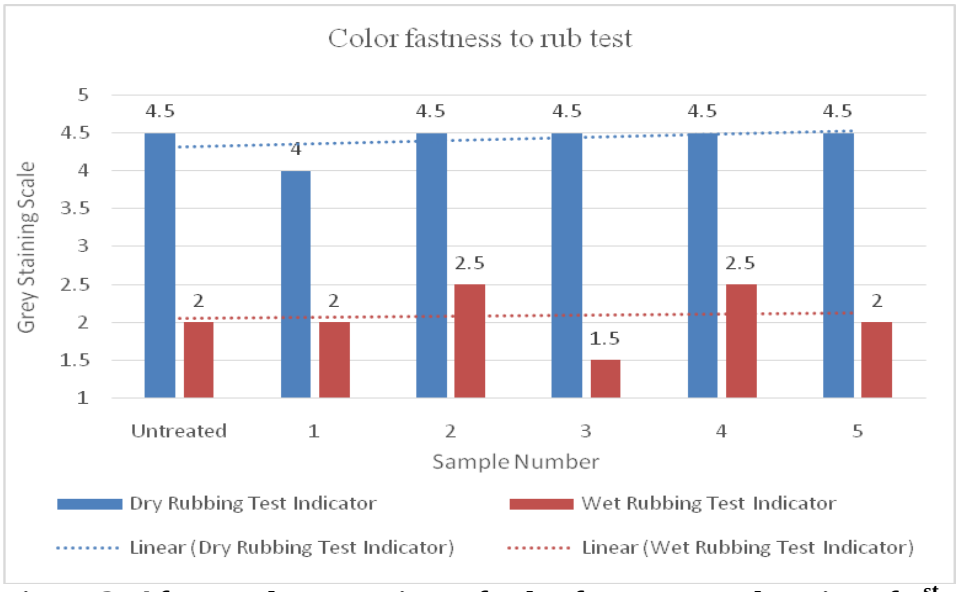

Figure 3: After wash comparison of color fastness to rub rating of 1st to 5th samples.

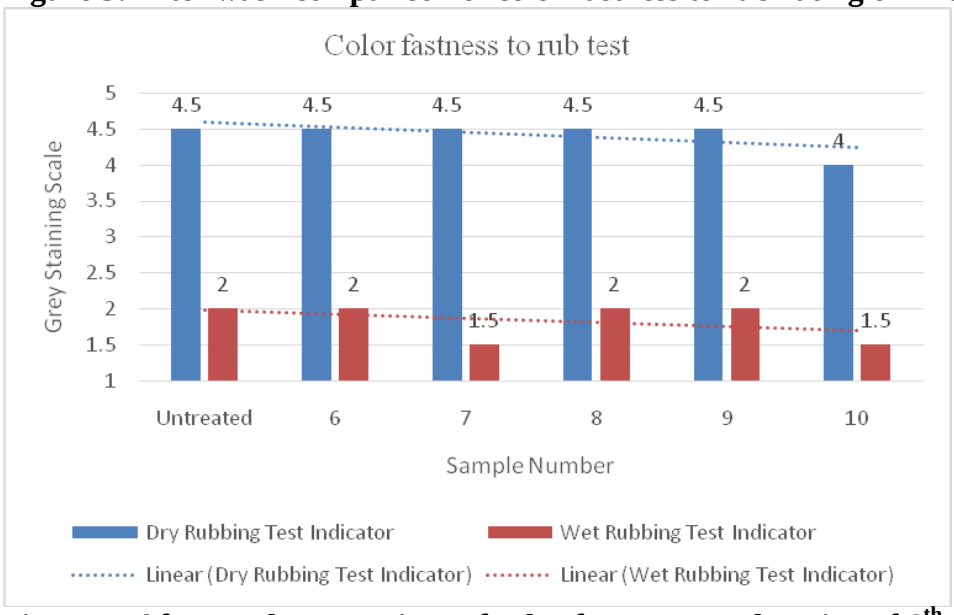

Figure 4: After wash comparison of color fastness to rub rating of 6th to 10th samples.

Samples for color fastness to rub test was assessed in light box under D65 light with Grey staining scale. Sample 1st to 5th (anti-creasing amount was fixed (2%) with Variable (2% - 6%) amount of softening agent) Grey staining scale rating tends to ascend for both dry and wet rubbing test means that the fastness rating will move to "Good (5)"rating from"Poor (1)".Sample 6th to 10th (softening agent amount was fixed (2%) with variable (2% - 6%) amount of anti-creasing agent) Grey staining scale rating tends to descend for both dry and wet rubbing test means that the fastness rating will move to "Poor (1)" rating from "Good (5)". So, this can be said that increasing the amount of softening agent will give better rubbing fastness and increasing the amount of anti-creasing agent will give poor rubbing fastness.

Shrinkage Comparison

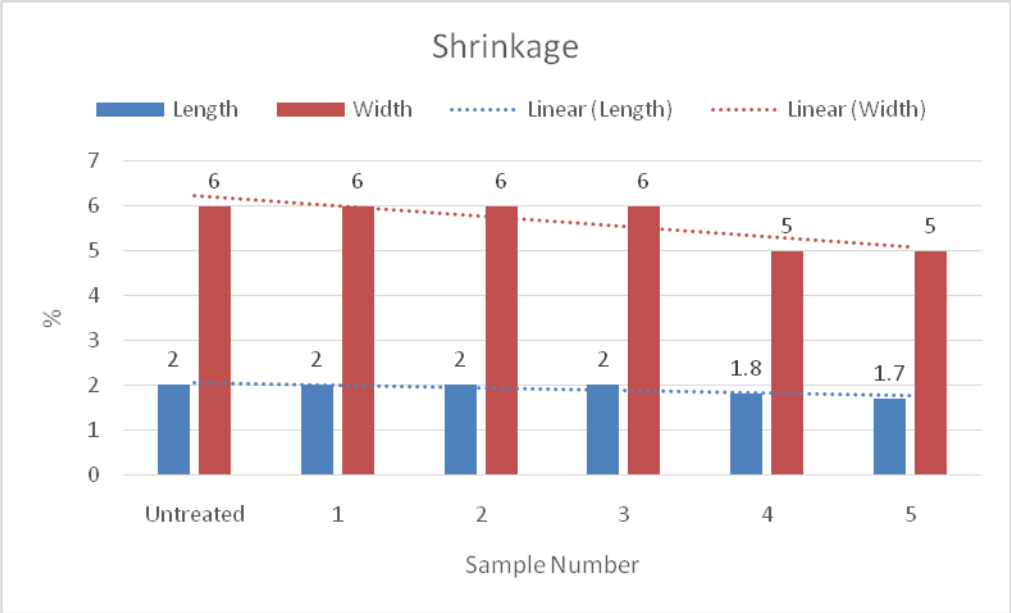

Figure 1: Shrinkage difference between sample no 1st – 5th.

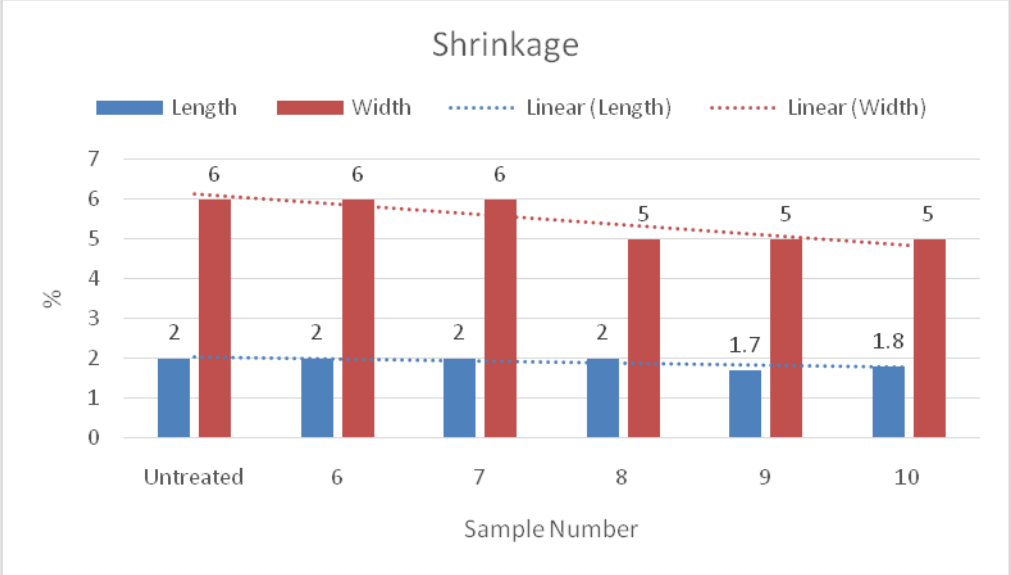

Figure 2: Shrinkage difference between sample no 6th – 10th.

Sample no 1st to5th and sample 6th to 10th, both batches showed similar properties after washing in case of shrinkage. Both the batches showed a very negligible difference in length and width shrinkage from the sample that has no finishing agents applied. But both batches have one similar effect which shows that the linear regression curve is going down when either of the agents are used in higher quantity. Which shows that increasing finishing agent amount can lower the shrinkage properties in both length and width of the fabric after washing.

Fabric GSM Comparison

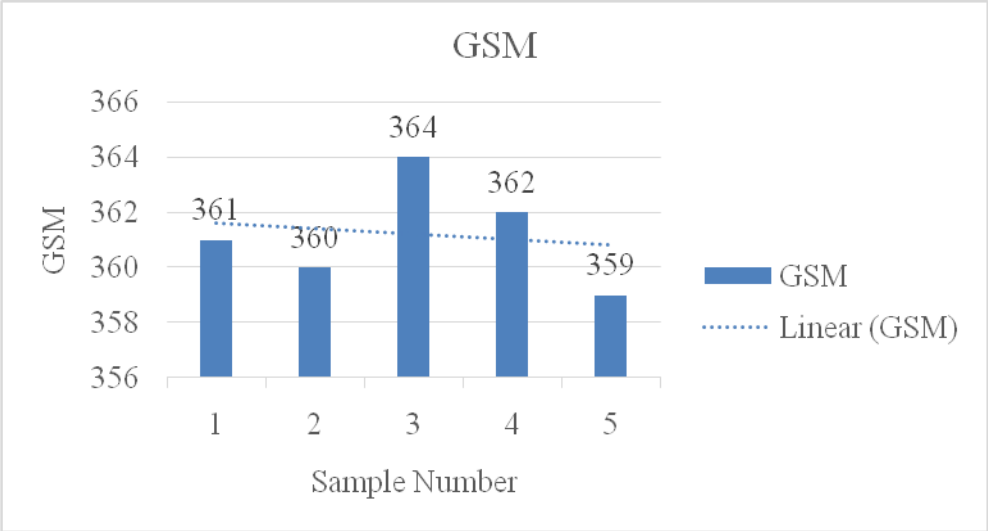

Figure 3: After wash GSM of 1st to 5th samples.

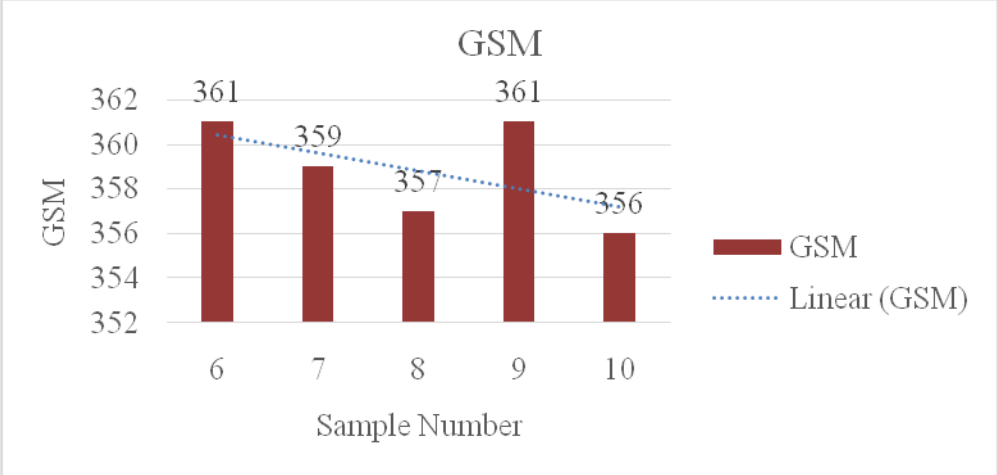

Figure 4: After wash GSM of 6th to 10th samples.

Sample 1st to 5th (anti-creasing amount was fixed (2%) with Variable (2% - 6%) amount of softening agent) and sample 6th to 10th (softening agent amount was fixed (2%) with variable (2% - 6%) amount of anti-creasing agent) both batches had tendency to have lower GSM than the untreated sample when amount of any of the finishing agent amount was increased.Using higher amount of finishing agent decreases the GSM of the knitted denim fabric after wash.

DISCUSSION

As for indigo dyes we know that they show a great level of color fastness to wash as they are water insoluble in natural form and only become water soluble when they are reduced to Leuco form. On the other hand,detergent having Sodium Perborate which is an oxidizing agent is used during wash fastness test which makes the dyes oxidized (water insoluble). So, the test specimen showed very less changes to color fastness to wash rating expect nylon fiber which reduces the property a little. So, color fastness to wash did not affected much for indigo with the changes of finishing agents amount as indigo (Vat dye) dyes have unparalleled level of fastness to wash.

Indigo dyes usually have a poor rubbing fastness. During dyeing, it creates ring effect means dyes stays on the surface of the fiber in a ring shape which is why it stains other fabric easily when rubbed specially in wet condition. For color fastness to rub, increasing amount of softening agent lowers the level of color fastness to rub for both dry and wet rub. On the other hand, increasing the amount of anti-creasing agent ascend the level of color fastness to rub for both dry and wet condition.

In case of shrinkage percentage, increasing any of the finishing agent (Softening / Anti-creasing) amount can lower the shrinkage properties in both length and width of the fabric after washing.On the other hand, finishing agent (Softening / Anti-creasing) lowers the GSM with compare to fabric having no finishing treatments.

CONCLUSION

This study shows the changes of properties after washing in knit denim fabric treated with different amount of softening and anti-creasing agent. Through this it will be easier to understand the maximum possible results about knitted denim washing. This study will also help to improve the washing of knitted denim produced garments in bulk.

Today's consumers' choice of clothing has shifted towards fast fashion, and they demand the right product at the right time and at the right price. Hence, the garment manufacturing units often find it hard to fulfil to consumer needs. Their demand for aesthetics, appearance, handle, luster and comfort in clothing is mainly achieved by chemical finishing and washing, especially in fabric form. However, some of these essential features may be deteriorated or lost during the conversion of fabric into the final garment. Hence, garment washing comes into play to obviate these issues. In addition, production of customized designs in specific locations of a garment, and some value-added finishes, are only feasible in the final garment. This study will be useful for better understanding the ways to control washing.

CONFLICT OF INTEREST

None.

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