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Research Article

Effect of Enzyme Wash (Cellulase Enzyme) on Properties of Different Weft Knitted Fabrics

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Abstract

This paper studied the effect of enzymatic treatment after dyeing by using cellulase as the enzyme on some properties of different structured weft knitted cotton fabrics i.e. plain single jersey, lycra (5%) plain single jersey, 1X1 rib, single lacoste, double lacoste and interlock. When fabric surface and hand feel are not good enough, the enzymatic wash is used for removing the pills and fuzz from fabric surface in order to improve the smoothness and hand feel of the fabric. Enzymatic washed fabrics exhibit a great difference in the physical and mechanical properties than the non enzymatic washed fabrics. But there are considerable changes in dimensional stability, GSM and bursting strength which affects the quality and price of the fabrics for making apparel or other domestic and industrial purposes. The experiment has been done in three phases i.e. grey state, after dyeing with 2% shade orange color with reactive dye and finishing without enzymatic wash state. Third state is eventually after finishing having washed with 1% enzyme to measure the variation in dimensional stability, GSM and bursting strength for the above mentioned fabrics. The fall of strength and GSM is observed after enzymatic treatment. Besides dimensional stability (Shrinkage and Spirality) becomes worse for lycra(5%) plain single jersey, 1x1 rib, double lacoste, plain single jersey and better for single lacoste and interlock weft knitted fabric. Moreover dimensional stability of the grey fabrics is the worst in the experiment. All the results derived from the study have been quantitatively discussed.

Keywords: *Enzyme, Spirality, shrinkage, GSM, Bursting Strength etc.*

1. Introduction

Enzymes can be defined as the biological molecules that catalyze (by increasing the rates of) chemical reactions. Enzymes have been employed in the finishing process of cellulosic textile materials for many years. The advantages of the utilization of specified enzymes for finishing process of cellulosic fabrics are listed as follows; cleaner fabric surface with less fuzz, process simplification, reduced tendency to pill formation, cost reduction, environmentally friendly process and improved handling properties of fabrics. The cellulase is the enzyme most widely used in finishing process of cellulosic fabric (Özdil, 2003). Cellulase is a complex natural mixture of different components, which work synergistically to degrade cellulose to glucose (Technical bulletin, 2002)). Cellulase enzymes are nontoxic, environmentally-friendly biocatalysts which are primarily used to bio-polishing process (Buschle-Diller, 1999). There is a great impact of fabric structure on enzymatic washing of various fabrics. Fabric properties mainly depend on the yarn properties, yarn arrangements in fabric i.e. fabric structure, chemicals and processes are used in pretreatment, dyeing and finishing. Structure of knitted fabric mostly depends on the presence of knit, miss and tucks loops. It is also affected by the interloping systems of loops such as in plain single jersey with or without lycra (Spandex) and double jersey fabric (Rib and interlock). Most of the knitted fabric is very difficult to singe in circular form for removing the hairiness. But the surface of the fabric can easily be cleaned by bio-polishing process by using cellulase. The main advantage of bio-polishing is the prevention of pilling (Olsen, 2004). The surface modification of cellulosic fabrics confers cooler and softer feel, brighter luminous color using cellulases (Choudhury, 2006). In the enzymatic treatment, producers of textile enzymes recommend dosages of approximately 0.05 to 6% of cellulase preparation on garment weight depending on the desired result, the treatment method and the activity of the enzyme product (Heikinheimo, 2002). The enzyme activities increase with temperature, but above a particular temperature the thermal agitation disrupts the tertiary structure of enzymes. Acid cellulases exhibit the greatest activity generally in the pH range of 4.5-5.5 at 45-55°C, whereas neutral cellulases require a pH 5.5-8.0 at 50-60°C.

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Table 1: Description of different fabric with yarn and machines specifications

No	Fabric Type	GSM	Combed Yarn Count (Ne)	Stitch length (mm)	Grey Dia (Inch)	Machine DiaxGauge
1	Lycra Plain Single Jersey	265	30/1 with 20D Lycra	3	76	36x24
2	1x1 rib	188	30/1	2.6	73	33x18
3	Single Lacoste	138	30/1	2.6	58	19x24
4	Double Lacoste	163	30/1	2.6	70	21x24
5	Plain Single Jersey	113	30/1	2.76	66	21x24
6	Interlock	212	30/1	3.15	78	32x24

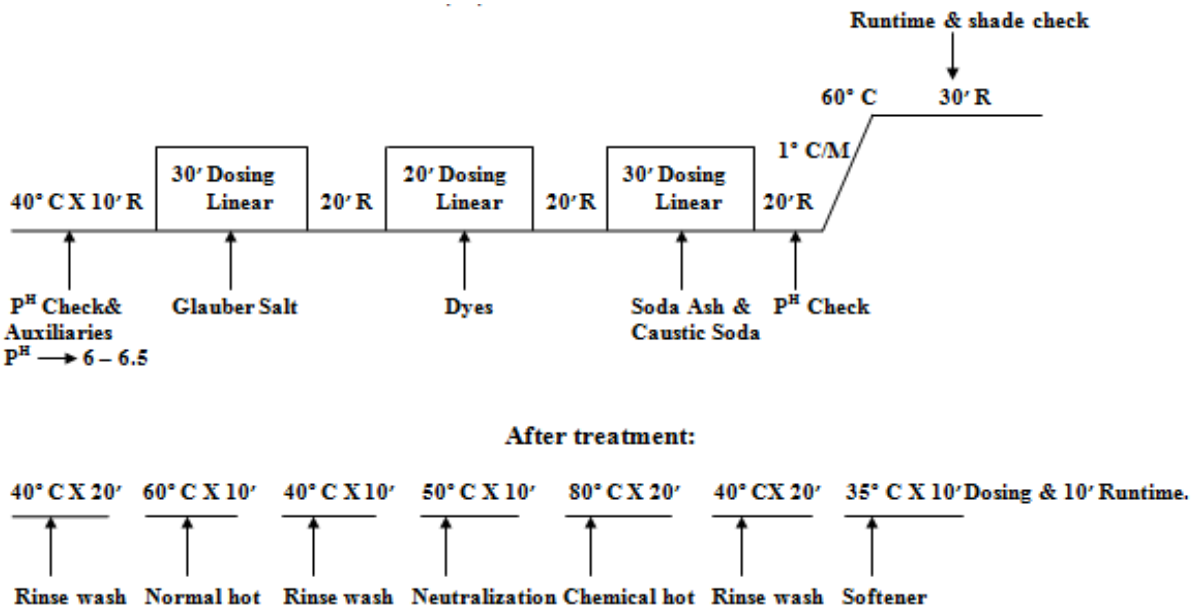

Figure 1: Dyeing curve

Generally a prolonged treatment time, excessive cellulase dosage and vigorous agitation may increase the fibre loss significantly(Choudhury,2006). Due to the un-optimized cellulose composition and high dosages, significant weight and strength losses can occur. Commercially a weight loss of 3-6% and strength loss of about 10% is considered acceptable (Choudhury, 2006). A suitable bio-polishing effect without excessive loss of fabric strength is generally obtained with 3.5% weight loss of fabric (Heikinheimo, 2002). Light bio-polishing may not be effective enough to remove fuzz and the presence of fuzz leads to fabric problems in wear, notably pilling and a frosted appearance, which causes an apparent loss of colour (Heikinheimo, 2002). Moreover, heavy bio-polishing will degrade cellulose causing fall ofGSM and bursting strength. Therefore to maintain standard GSM and bursting strength in the finishing processes: proper chemical concentration, pH, temperature and time of treatment for optimum production and good quality fabrics must be controlled by settings.

2. Material and Method

For this study six types of fabric have been produced from the same yarn of count and same lot. Yarn from the same lot is placed in the creels carefully for knitting. The fabrics were produced by using the parameters (Table 1)

After knitting, the samples were dried in relaxed condition & then processed that includes conditioning of the fabrics at 65% relative humidity & 30°C ± 2°C. After relaxation, the following tests were carried out at 27°C± 2°C & 65% RH. In grey state GSM, dimensional stability(Shrinkage and spirality) and bursting strength were measured . Then all six types grey fabrics have been scoured, bleached and dyed together with 2% shade orange color without enzyme and these were finished with same setting and 1 m fabric is taken from each fabric to test GSM, dimensional stability(Shrinkage and spirality) and bursting strength again for those fabric dyed with 2% shade without enzyme. Again those fabrics were loaded in dyeing for treatment with 1% enzyme. Then those samples were finished and GSM, dimensional stability (Shrinkage and spirality) and bursting strength were measured again. Thus all the experimental data has been derived.

2.1. Dyeing Recipe

The following recipe was used for dyeing the samples:

Dye (Reactive): Imcozine Red E3BF-0.26%
Synozol Bright Orange KR-0.6%
Sunfron Yellow SN2R-0.8%
Salt : 50gm/l
Soda : 5gm/l
Caustic soda : 0.3gm/l

Table 2: Dimensional stability (Shrinkage and Spirality) test results of the samples

No	Fabric Type	Grey state			Without enzyme			With Enzyme		
		L%	W%	Sp%	L%	W%	Sp%	L%	W%	Sp%
1	Lycra Plain Single Jersey	-11.4	-5.7	1.5	-3	1.4	0	-8.5	-1.4	8.8
2	1x1 rib	-11.3	-11.3	0	0	-1.6	2	-1.4	-2.8	2.5
3	Single Lacoste	-22.8	-11.4	4.5	-2.8	-2.8	0.5	0	-2.8	0.2
4	Double Lacoste	-20	-10	1	-9.9	2.8	0	-10	5	2
5	Plain Single Jersey	-4.2	-25.8	16.4	-2.8	1.5	3.8	-1.4	-2.8	9.5
6	Interlock	-18	-12.8	2	-7	7.1	0.5	-4	1.4	0.5

(L%= Length wise Shrinkage Percentage, W%= Width wise Shrinkage Percentage and Sp%= Spirality Percentage)

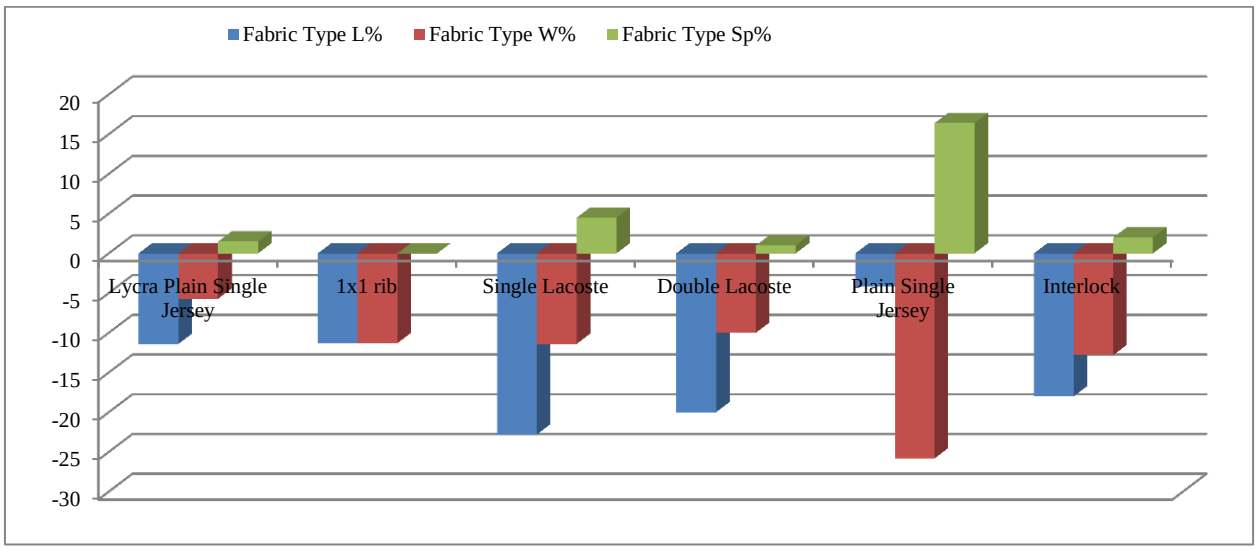

Figure 2: Dimensional stability (Shrinkage and Spirality) test result in grey state

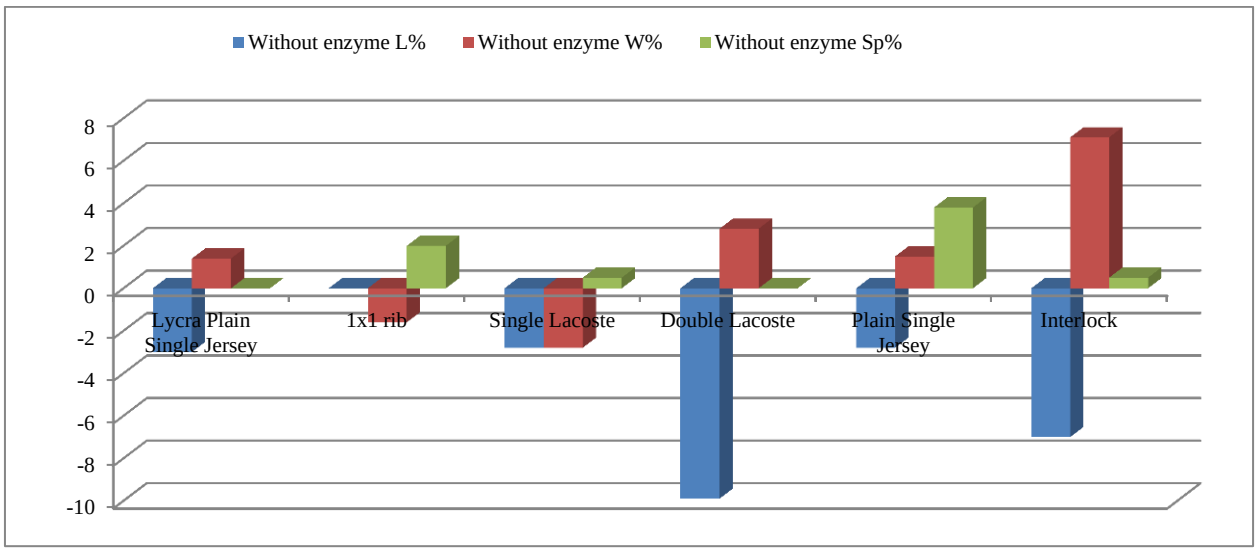

Figure 3: Dimensional stability (Shrinkage and Spirality) test result without enzyme wash

2.2. Dyeing curve

It is shown in figure 1.

2.3. Enzyme Specification

Name : Enzyme-Ecozyme LXN
Concentration : 1gm/l
Temperature : 55 °C
Time : 1 hour

2.4.1. Determination of Fabric Weight (GSM)

After relaxation & conditioning of knit fabric samples, GSM of samples were tested by taking test samples with the help of GSM cutter & weighting electronic balance (ASTM D3776, 2013).

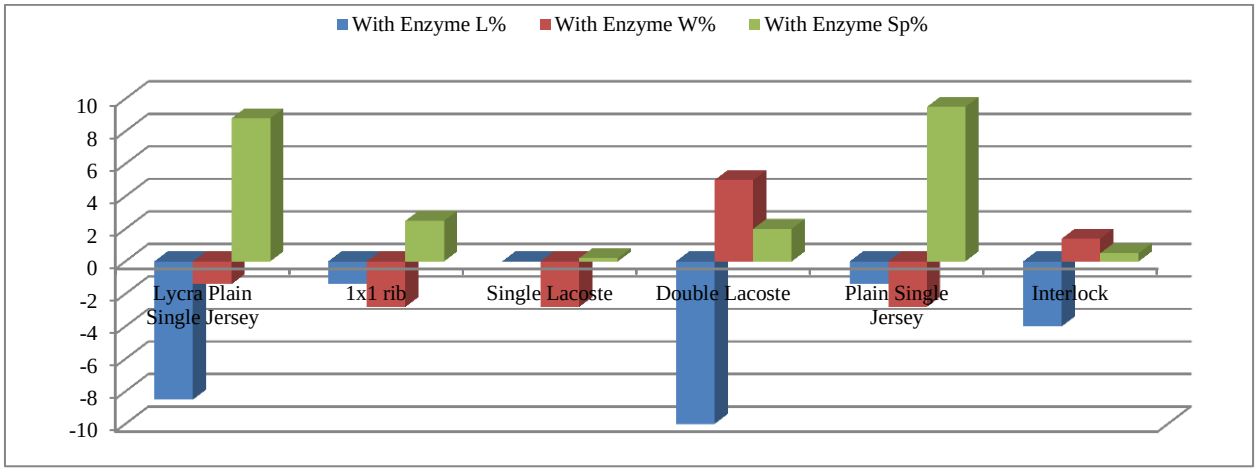

Figure 4: Dimensional stability (Shrinkage and Spirality) test result with enzyme wash

Table 3: GSM test result of the samples

GSM				
No	Fabric Type	Grey state	Without Enzyme	With Enzyme
1	Lycra Plain Single Jersey	259	222	203
2	1x1 rib	182	212	211
3	Single Lacoste	142	180	176
4	Double Lacoste	168	189	186
5	Plain Single Jersey	121	150	140
6	Interlock	212	255	251

Table 4: Bursting Strength test result of the samples

No	Fabric Type	Bursting Strength(Kpa)		
		Grey state	Without enzyme	With enzyme
1	Lycra Plain Single Jersey	449.9	454.4	412.8
2	1x1 rib	729.8	748.3	641.5
3	Single Lacoste	675.9	590.7	494.4
4	Double Lacoste	616.7	460	379.3
5	Plain Single Jersey	607.5	646.5	526.2
6	Interlock	1063	1047.5	807.1

2.4.2. Determination of dimensional stability (Shrinkage and Spirality)

First cut a sample of (50cm×50cm) with the scissor. Then by the over lock sewing m/c the 4 ends of the cut fabric were sewn. After sewing, again by a scale mark (25cm×35cm) on the fabric& then sample washed with a standard soap solution (1g/l). After washing the sample was line dried at 65°C± 15°C for 60 minutes. Then after cooling the sample tested with the shrinkage tester scale also the spirality was tested. Shrinkage was tested length wise & width wise along the mark of (35cm×35cm) and spirality was tested along sewing line alignment (AATCC187, 2013).

2.4.3. Determination of bursting strength

Bursting strength of samples was measured by an automatic bursting strength tester. Samples are gradually set on the diaphragm, the automatic bursting strength tester, measures time, distortion, pressure & the flow rate to burst the fabric. For different samples we recovered there parameters (ASTM D3786, 2013).

3. Results & Discussion

3.1. Dimensional Stability test

The test is shown in table 2.

In case of dimensional stability, shrinkage test result becomes worse for lycra plain single jersey, 1x1 rib, double lacoste, plain single jersey and better for single lacoste and interlock. Variation in result is seen due to difference in fabric design.

3.2. GSM test

This is shown in table 3.

3.3. Bursting test

It is shown in table 4.

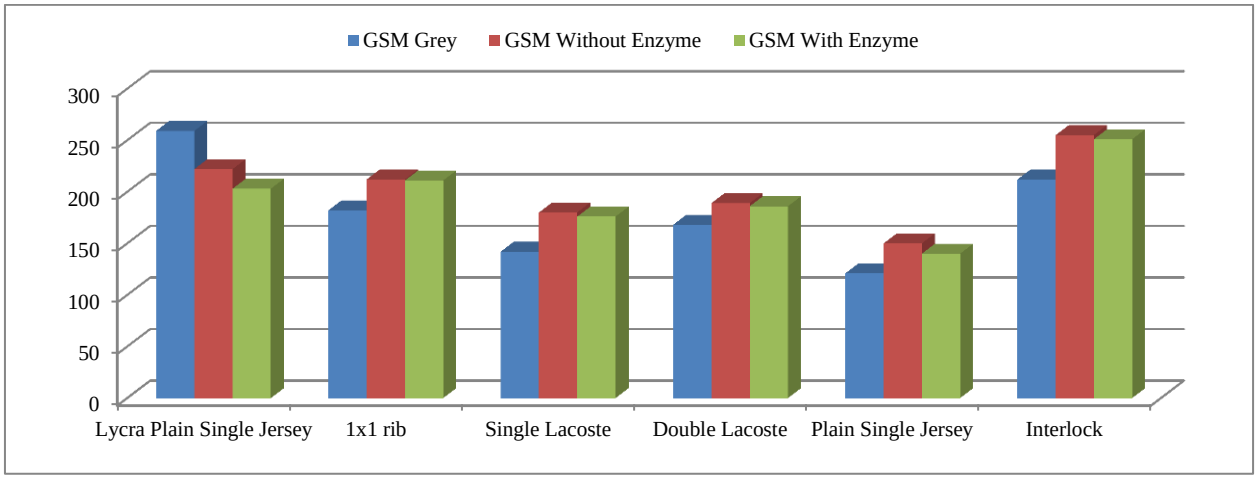

Figure 5: GSM test result in various states

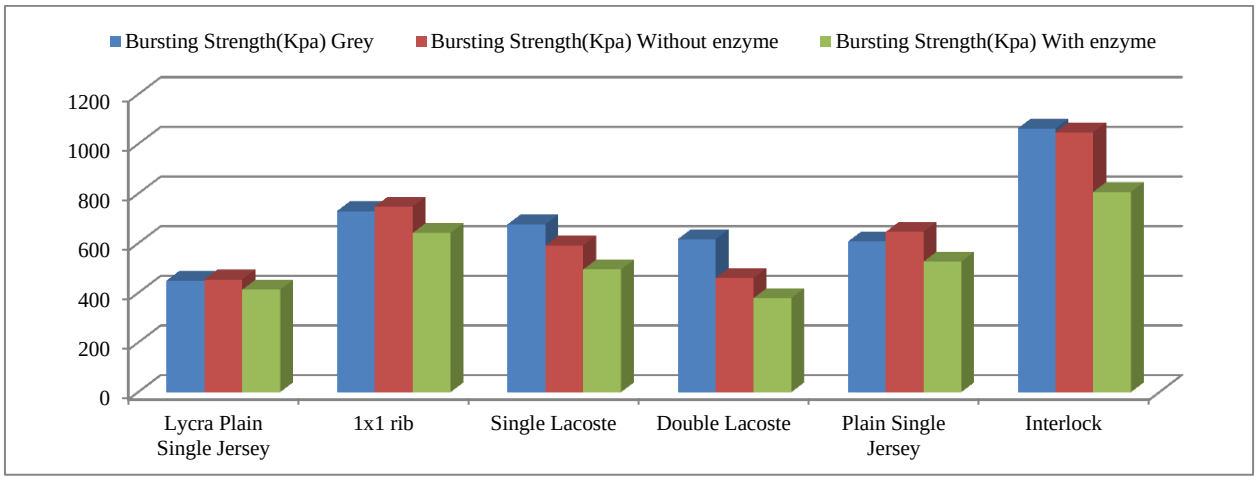

Figure 6: Bursting test result in various states

Fall in the bursting strength due to use of enzyme is noticed in the test result. Besides difference in the fabric structure has an effect on the results of bursting strength.

Conclusion

In this research, changes of three properties of different weft knitted fabrics were observed due to use of enzyme. Shrinkage test result worsens for lycra plain single jersey, 1x1 rib, double lacoste, plain single jersey. So it is concluded that enzyme acts on the fibres resulting in more instability. Dimensional properties of single lacoste and interlock fabrics have improved after using enzyme. Because single lacoste has less tuck loop imparting less yarn consumption and interlock is produced from double jersey machine with interlocked structure. Variation in the result is obvious due to internal fabric design difference.

Besides fabric made from same yarn has reduced its strength due to use of enzyme .Enzyme deteriorates the fibre strength acting on it. Enzyme makes the surface smooth by removing some pill and fuzz. As a result, weight loss is evident. Therefore GSM has been reduced due to use of enzyme. So the use of enzyme should be regulated according to requirement. The more application of enzyme will cause more deterioration of the cellulose making fibre worse in strength.

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