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Impact of enzymatic pretreatments on physical properties of cotton fabric

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Abstract
This study investigates the impact of enzymatic desizing and scouring on the physical properties of untreated cotton fabric. Desizing was carried out using 3% alpha-amylase enzyme, followed by enzymatic scouring with 2% pectinase to remove sizing agents and natural impurities, respectively. The treated fabric was analyzed for changes in geometrical, mechanical, and comfort-related properties using standard test methods. Results showed a non-significant increase in fabric count and decrease in thickness, while the reduction in fabric weight was statistically significant at the 1% level. Tensile strength exhibited a slight, non-significant decline, whereas elongation increased marginally. Comfort properties such as bending length and moisture regain decreased but remained statistically non-significant. Overall, enzymatic pretreatments effectively enhanced fabric purity with minimal impact on its physical characteristics, supporting their suitability as eco-friendly preparatory processes in textile manufacturing.

Keywords: Enzymatic pretreatment, cotton fabric, alpha-amylase, pectinase, desizing, scouring, physical properties, eco-friendly textile processing

1. Introduction
Cotton fabric, renowned for its comfort, breathability, and versatility, remains the most commonly utilized natural fibers in the fabric and clothing sector. However, the raw cotton fabric often contains various impurities such as sizing agents, pectin, waxes, oils, and other natural contaminants that adversely affect its dyeing, finishing, and overall performance characteristics. Therefore, preparatory processes such as desizing and scouring are essential to remove these impurities, enhancing the fabric's absorbency, uniformity, and readiness for subsequent textile treatments.

Desizing primarily involves the removal of starch-based sizing agents applied during weaving to protect yarns, whereas scouring eliminates natural impurities including pectins, fats, and waxes that cause uneven dyeing and poor fabric quality. Traditionally, harsh chemical methods were employed for these processes, but enzymatic treatments have gained prominence due to their environmental friendliness, specificity, and efficiency in targeting impurities without damaging the fabric structure.

This study focuses on evaluating the impact of enzymatic desizing and scouring on the physical properties of grey cotton fabric. By analyzing changes in geometrical, mechanical, and comfort-related properties after enzymatic treatment, the research aims to understand how these preparatory processes influence fabric quality and performance. The outcomes are intended to provide insights into optimizing enzymatic treatments to improve fabric characteristics while maintaining structural integrity.

2. Materials and Methods
2.1 Procurement of raw materials
Cotton fabric was sourced through a market survey conducted in Hisar city. Samples from various stores were visually screened and tested using physical, burning, and solubility methods to confirm purity of cotton fabric. Among screened samples medium-weight grey cotton fabric was choosen, as it is untreated and free from finishing processes, ensuring unbiased results and making it ideal for the study.

2.2 Desizing of fabric
Desizing removes the sizing material applied to yarns before weaving to enhance chemical penetration in later processes. In this study, the fabric was treated with 3% alpha amylase enzyme at a material-to-liquor ratio of 1:20, maintained at 60 °C for 45 minutes within a pH range of 6 to 7. After enzymatic desizing, the fabric was thoroughly rinsed first with hot water, then with cold water, and finally dried in a hot air oven at 80 °C.

2.3. Scouring of fabric
Natural fibers contain impurities like pectin, fats, waxes, oils, hemicelluloses, and minerals, which can cause uneven absorption if not properly removed. To eliminate these, the desized fabric underwent enzymatic scouring using 2% pectinase at a 1:20 material-to-liquor ratio, maintained at 40 °C for 45 minutes at pH 8. Following the treatment, the fabric was carefully rinsed first with hot water, then with cold water, and subsequently dried in a hot air oven at 80°C.

2.4 Testing of Physical properties of cotton fabric
Physical properties of the selected grey cotton fabric was studied using standard test procedures under standard test conditions.

Table 1: Instruments and Test Standards used

Physical properties	Sample Size	Instruments	Standard Methods
Fabric count (ends and picks per sq. inch)	6''x 6''	Paramount Pick Glass with Pointer	ASTM- D123
Fabric weight (g/m^2)	Template Size	GCM Quadrant Balance	ASTMD-377960
Fabric thickness (mm)	4''x 4''	Thickness Tester	BS 2544: 1967
Bending length (cm)	25x200 Mm	Paramount Stiffness Tester	BS 3356: 1961
Tensile strength (kg) & Elongation (%)	Template Size	Paramount Tensile Strength Tester	IS 4169
Moisture Regain (%)	4''x 4''	Oven dry method and Weighing Balance	BS 1051:1964

2.4.1 Geometrical properties: "To determine the geometric properties i.e. fabric count, weight, and thickness of the desized and scoured cotton fabric, an average of five readings was taken for each test.

2.4.2 Mechanical Properties: The mechanical properties, namely tensile strength and elongation, were tested to evaluate the influence of preparatory treatments on cotton fabric. Standardized testing methods, as described below, were employed for this analysis.

a) Tensile strength: ""Tensile strength refers to a fabric's capacity to endure applied force without breaking. The tensile strength of the fabric, after preparatory processes, was measured using a Paramount Tensile Tester following the IS 4169 testing standard.

b) Elongation: "Elongation is the ability of the fabric to be stretched, extended or lengthened". The elongation of the fabric was measured using the Paramount Tensile Tester in accordance with the IS 4169 testing method. The percentage of elongation at the breaking point was determined using the following formula:

$$\text{Elongation at break } (\%) = Lf - \frac{Li}{Li} x100$$

Where,
L_i= initial reading
L_f= Final reading

2.4.3 Comfort properties: To evaluate the effect of desizing and scouring on the comfort characteristics of cotton fabric, bending length and moisture regain were analyzed. These comfort-related characteristics were evaluated using standard test methods as outlined below.

- **Fabric bending length:** The bending length of the fabric samples was measured using the Paramount Stiffness Tester following the BS 3356:1961 test method. Five fabric samples were tested, with each sample assessed four times once at each edge. A total of 20 readings were taken in both warp and weft directions, and the average bending length was calculated using the standard formula:

C = l x f (o)

Where,
C= bending length
F (o) = 0.5
l= length reading on the bending meter

- **Moisture regain:** Moisture regain refers to the percentage of water content present in a textile material, relative to its oven-dry weight, and is measured using a standardized method. In this study, moisture regain was assessed following the BS 1051:1964 testing procedure. The moisture percentage was calculated using the following formula:

$$\text{Moisture regain } (\%) = \frac{\text{Original weight} - \text{Oven dry weight}}{\text{Oven dry weight}} \times 100$$

3. Results and Discussion
The present study was undertaken to check the effect of enzymatic desizing and scouring on physical properties of cotton fabric. The physical properties of cotton fabric were studied by using standard test methods. The results are presented as follows:

3.1 Preliminary properties of the cotton fabric
Medium-weight untreated cotton fabric was chosen for the study. The selected fabric was evaluated for three parameters: fabric count, weight, and thickness. The data in Table 1 showed that the fabric count of grey cotton fabric was 54×35 picks/sq. inch with 0.41 mm thickness and 127 g/m^2 weight.

Table 2: Preliminary properties of the cotton fabric

Properties Fabric	Fabric count (ends and picks/sq. inch)	Fabric weight (g/m^2)	Fabric thickness (mm)
Cotton fabric	54×35	127	0.41

3.2 Effect of desizing and scouring on physical properties of grey cotton fabric

The selected cotton fabric underwent preparatory treatments, including desizing and scouring, to remove starch and impurities, enhancing its absorbency for subsequent textile processes. Scouring followed desizing to ensure thorough removal of all unwanted substances. The pre-treated grey cotton fabric was then analyzed for changes in its physical properties, including geometric, mechanical, and comfort characteristics.

3.2.1 Geometrical properties of cotton fabric

To evaluate the effects of preparatory treatments on grey cotton fabric, geometrical properties including fabric count, weight, and thickness were analyzed. Table 2 shows that after desizing and scouring, fabric count of grey cotton fabric was increased from 54±0.45 to 56±1.18 ends and picks per sq. inch in warp direction and from 35±0.23 to 36±0.89 ends and picks per sq. inch in weft direction. The fabric count changed by 5.35% in the warp direction and 1.94% in the weft direction, with corresponding t-values of 0.07 and 0.29, respectively. This increase in fabric count for both directions was determined to be statistically non-significant.

After desizing and scouring thickness and weight of the grey cotton fabric decreased from 0.41 ± 0.18 mm to 0.40 ± 0.17 mm, and 127 ± 1.12 g/m² to 123 ± 1.18 g/m², reflecting a 2.43% and 3.40% reduction, respectively. The t-values for thickness and weight were 0.14 and 0.05. The decrease in thickness was statistically non-significant, while the reduction in weight was significant at the 1% level.

Thus, as shown in Table 2, desizing and scouring caused a non-significant change in geometrical properties, except for fabric count.

Table 2: Effect of preparatory processes on geometrical properties of cotton fabric

Fabric Geometrical properties		Grey fabric Mean ± S.E	Desized and scoured fabric Mean ± S.E	Per cent Change	t-value
Fabric count (ends and picks per square inch)	Warp	54±0.45	56±1.18	+ 5.35	0.07
	Weft	35±0.23	36±0.89	+ 1.94	0.29
Weight per unit area (g/m^2)		127±1.12	123±1.18	- 3.40	0.05**
Thickness (mm)		0.41±0.18	0.40±0.17	- 2.43	0.14

**Significant at 1% level of significance, *Significant at 5% level of significance

3.2.2 Mechanical properties of cotton fabric

Table 3 shows that after desizing and scouring the tensile strength of grey cotton fabric in the warp and weft directions was decreased from 22.04 ± 0.61 to 21.3 ± 0.65 kg in the warp and 13.5 ± 1.08 to 12.7 ± 1.25 kg in the weft, indicating a reduction of 0.53% and 5.74%. The corresponding t-values were 0.18 and 0.37. This decrease in tensile strength in both directions was found to be statistically non-significant.

Elongation in both warp and weft directions of grey cotton fabric increased after desizing and scouring. Initially, elongation was 14.57 ± 0.45% in the warp and 21.3 ± 1.64% in the weft, which rose to 15.5 ± 0.65% and 22.83 ± 1.48%, respectively, following pretreatment. This represented increases of 5.99% and 6.71%, with t-values of 0.20 and 0.31. The increase in elongation for both directions was statistically non-significant.

Overall, the findings shows a slight decrease in tensile strength and a slight increase in elongation after desizing and scouring, which were statistically non-significant.

Table 3: Effect of pre-treatment processes on mechanical properties of cotton fabric

Fabric Mechanical properties		Grey fabric Mean ± S.E	Desized and scoured fabric Mean ± S.E	Per cent Change	t-value
Tensile strength (kg)	Warp	22.4±0.61	21.3±0.65	- 0.53	0.18
	Weft	13.5±1.08	12.7±1.25	- 5.74	0.37
Elongation (%)	Warp	14.57±0.45	15.5±0.65	+5.99	0.20
	Weft	21.3±1.64	22.83±1.48	+6.71	0.31

**Significant at 1% level of significance, *Significant at 5% level of significance

3.2.3 Comfort properties of cotton fabric

Bending length and moisture regain, as indicators of comfort properties, were measured to evaluate the effects of preparatory processes on cotton fabric. According to Table 4, after desizing and scouring the bending length of grey cotton fabric was decreased from 4.33 ± 0.07 cm to 4.08 ± 0.07 cm (warp) and 4.86 ± 0.06 cm to 4.64 ± 0.12 cm (weft), showing changes of 6.12% and 4.74%, with t-values of 0.06 and 0.14, respectively. The reduction in bending length (weft direction) was found to be non-significant. Moisture regain dropped from 4.7 ± 0.08% to 4.60 ± 0.04%, a 2.12% decrease with a 0.24 t-value, also non-significant.

Table 4: Effect of preparatory processes on comfort properties of cotton fabric

Fabric Comfort properties		Grey fabric Mean ± S.E	Desized and scoured fabric Mean ± S.E	Per cent Change	t-value
Bending length (cm)	Warp	4.33±0.07	4.08±0.07	- 6.12	0.06
	Weft	4.86±0.06	4.64±0.12	- 4.74	0.14
Moisture regain (%)		4.7±0.08	4.6±0.04	-2.12	0.24

**Significant at 1% level of significance, *Significant at 5% level of significance

4. Conclusion

Enzymatic desizing and scouring were performed to assess the impact of pre-treatment on physical properties of grey cotton fabric by removal of impurities and starch. The increase in fabric count in warp (5.35%) and weft (1.94%) directions and decrease in thickness (2.43%) of the fabric was found to be non-significant, while decrease in weight per unit area (3.40%) was found to be significant at 1 per cent level of significance. Tensile strength showed a decrease of 0.53% in the warp direction and 5.74% in the weft direction, while the increases in elongation which was 5.99% in warp and 6.71% in weft, and were determined to be non-significant. Similarly, the reductions in bending length of 6.12% (warp) and 4.74% (weft) were also non-significant. Moisture regain declined by 2.12%. Overall, these changes were considered statistically non-significant

References

1. Arpita. Effect of biopolymer treatment on antimicrobial efficacy of nano finished cotton fabric [Doctoral thesis]. Hisar: Department of Apparel and Textile Science, CCS Haryana Agricultural University; 2024.
2. Gulrajani ML. Advances in textile wet processing. Cambridge: Woodhead Publishing; 2014.
3. Jamal Z. Effect of extract of guava leaves on cotton for microbial resistance [Master's thesis]. Hisar: Department of Textile and Apparel Designing, CCS Haryana Agricultural University; 2016.
4. Kadolph SJ. Textiles. 10th ed. Upper Saddle River (NJ): Pearson Prentice Hall; 2007.
5. Kilinc-Balci FS. How consumers perceive comfort in apparel. In: Improving comfort in clothing. Cambridge: Woodhead Publishing; 2011. p. 97-113.
6. Medha K. Antibacterial finish on cotton using giloy extract [Master's thesis]. Hisar: Department of Textile and Apparel Designing, CCS Haryana Agricultural University; 2019.
7. Poonia N. Efficacy of kinnow peels extract for microbial resistance on cotton fabric [Master's thesis]. Hisar: Department of Textile and Apparel Designing, CCS Haryana Agricultural University; 2018.
8. Rajendran S, Vigneshwaran N, Kumar R. Enzymatic scouring of cotton fabric using pectinase enzyme. J Cleaner Prod. 2011;19(4):345-350.
9. Reena. Application of weed plant extract on cotton fabric for microbial resistance [Master's thesis]. Hisar: Department of Textile and Apparel Designing, CCS Haryana Agricultural University; 2020.
10. Rulhania R, Arya N, Sushila, Parul. Effect of preparatory processes on physical properties of cotton fabric. J Pharmacogn Phytochem. 2021;10(1):2720-2724.
11. Teli MD, Desai P. Enzymatic treatment of cotton fabric: An eco-friendly approach for textile processing. Int J Environ Sci Technol. 2010;7(1):59-68.
12. Vigneshwaran N, Kathe AA, Varadarajan PV, Nachane RP, Balasubramanya RH. Biomimetics of silver nanoparticles by white rot fungus, *Phaenerochaete chrysosporium*. Colloids Surf B Biointerfaces. 2006;53(1):55-59.