J. Cotton Res. Dev. **38**(1), 85-90 (January, 2024) **ISSN No. 0972-8619**

Effect of Pre Treatment on Physical Properties of Cotton Fabric

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Abstract : Cotton fiber is widely utilized as a natural fiber in the textile and garment industries. Pre treatment processes are employed to remove both extraneous and inherent contaminants from the fabric. Typically, the pre treatment of cotton fabric before dyeing and finishing predominantly involves a combination of desizing and scouring processes. The physical qualities of the cloth were examined using established test techniques after desizing and scouring. The study's results indicated that all geometric attributes of cotton fabric, including fabric count, weight/unit area, and thickness, increased insignificantly following the desizing and scouring processes. Additionally, the findings showed a decrease in tensile strength, a slight increase in bending length and elongation. Further more, the study revealed that desizing and scouring of the cotton fabric led to an enhancement in wickability and flexural stiffness, while simultaneously reducing moisture regain.

Keywords: Cotton, desizing, physical properties, scouring

Cotton is one of the most extensively used materials and holds a dominant position among other textile and garment materials. Cotton fiber's dominance is primarily due to its natural comfort, appearance, and excellent performance such as alkali resistance, hygroscopicity, and moisture retention, despite its poor crease recovery, dye fixation, antibacterial properties, photo-yellowing, and colour fastness (Wang *et al.*, 2020). Cotton is a natural fiber with substantial commercial value. The most common organic polymer on the globe, cellulose, has the chemical formula $(C_6H_{10}O_5)_n$. It is a polysaccharide composed of a linear chain consisting of several hundred to over ten thousand linked D-glucose units. The majority of cotton fiber is made of cellulose, with various non cellulosic components surrounding the cellulose core. (Reena *et al*, 2020). As an alternative to standard wet chemical processing, the textile industry is progressively looking for a more cost-effective and environmentally friendly cotton preparation procedure (Ebrahimi *et al.*, 2011).

Desizing and scouring are two preparatory operations used to remove size material and impurities from cloth without affecting the physical and chemical qualities of the fabric. Fabric physical qualities are important because they determine the fabric's usefulness. The physical characteristics encompassed geometric, mechanical, and comfort-related aspects. Among the geometric attributes of cotton fabric are factors such as fabric count, weight, and thickness, among others. (Poonia,2018)

Tensile strength and elongation are examples of mechanical qualities. Tensile strength refers to a material's capacity to endure a pulling force before experiencing failure, such as breaking or permanent deformation. It quantifies force relative to the material's cross sectional area. The elongation of the fabric at the point of rupture is a measurement connected to tensile strength and represents the initial length of the sample. Fabric comfort related properties comprise factors like bending length, flexural stiffness, moisture recovery, and air permeability. (Sushila, 2018) defines Moisture recovery, expressed as a percentage of the oven dry weight, represents the weight of water within a material. Flexural stiffness refers to the force required to bend a non-rigid material. The principal aim of this study was to investigate how pretreatment affected the physical characteristics of cotton fabric. A fabric's functionality is largely determined by its physical properties, which encompass factors related to comfort, mechanics, and geometry. Among the geometric characteristics of cotton fabric are fabric count, weight and thickness. Mechanical properties include things like bending length, tensile strength, and elongation, flexural rigidity, moisture regain, and fabric wickability are all examples of comfort qualities.

MATERIALS AND METHODS

Selection of raw material: Three samples of gray, medium weight cotton fabric were procured from Hisar, from local market. Visual inspection and physical and chemical testing were used to screen the samples that were gathered. The cotton cloth underwent scorching, microscopic, and chemical tests to verify its purity.

Desizing: Desizing removes sizing materials like starch could hinder uniform dyeing of textile. The fabric was weighted and pre wetted prior to introducing into the desizing bath. The fabric was completely squeezed before being treated in a bath with 0.5 per cent sulfuric acid and 0.5 per cent wetting agent on the weight of the fabric with MLR 1:30. It was continuously stirred for 60 minutes while being maintained at 600 degrees. The fabric was removed after the requisite amount of time, thoroughly rinsed with water, and dried. (Jose *et al.*, 2016).

Scouring: Natural fibers have impurities like pectin, fats, hemicelluloses, oils, minerals and waxes. If such materials are not properly removed from the substrate, this will inevitably lead to patchy or uneven dyeing. The desized fabric was initially weighted and soaked in water. Then, using MLR 1:20, it was added to the scouring bath with the necessary concentrations of sodium carbonate (2.0%), sodium hydroxide (5.0%), and wetting agent (0.5%). The fabric was treated for 60 minutes at a temperature of 90ºC, which was gradually increased. For an additional hour, the scouring was maintained with sporadic stirring. After washing the scrubbed fabric in water and neutralizing it with a mild acetic acid solution, it was dried at room temperature. e (Jose *et al.*, 2016).

Preliminary properties of the cotton fabric

The preliminary data of the selected cotton fabric was taken under three parameters *i.e.* fabric count, weight and thickness. The samples were conditioned prior to determination of fabric dimensions under standard test conditions *i.e.* relative humidity 65± 2 per cent and temperature 27 ± 2°C.

Geometrical properties: To evaluate the impact of the preparatory methods on the fabric, a range of geometric parameters for the desized and scoured cotton fabric were examined, which included fabric count, weight, and thickness. These geometric attributes of the samples were assessed using well established conventional test procedures, as detailed below..

Fabric count: The fabric count was determined following the ASTM-D123 standard test procedure. A prominent pick glass with a pointer was employed for this purpose. The fabric count was measured by "counting the number of threads/square inch in both the warp and weft directions at five different locations on the fabric." Subsequently, an average of these five readings was calculated for accuracy.

Fabric weight: Samples were randomly cut from the fabric using a circular cutter to determine the GSM (g/sq. m.). The ASTM-D 3776-90 standard test procedure was followed for this purpose. Each sample was individually weighed using the Paramount Precision Scale to obtain its weight in grams. The weight/unit area was then calculated in grams/square meter, utilizing an average derived from five readings for accuracy.

Fabric thickness: The thickness of the fabric was assessed using the ASTM D1777-60 test method, employing a Paramount thickness tester. A meticulously prepared specimen, ensuring it was free from any folds, crushing, distortion, or wrinkles, was laid flat beneath the pressure foot of the instrument. After gently lowering the pressure foot onto the specimen and observing the dial meter's pointer come to a stop, the measurement in millimeters was recorded from the digital gauge. To ensure accuracy, an average thickness value was subsequently computed based on five such readings.

Mechanical properties

To determine how preparation techniques affected the mechanical properties of the cloth, tests were done on its bending length, tensile strength, and elongation. According to the conventional test procedures listed below, these characteristics of fabric samples were investigated.

Bending length: The crucial stiffness tester utilized the BS 3356:1961 standard test method to measure the bending length of the samples, measuring 25 × 200 mm, were carefully cut from both the warp and weft directions and appropriately conditioned. The zero mark on the scale and the zero line etched on the side of the plate aligned precisely with the placement of the template and samples on the platform, ensuring the fabric was positioned beneath. The bending length for both directions was then read from the scale, which corresponded to the front edge of the top plate. Each sample underwent testing five times on each edge for accuracy.

Tensile strength: The tensile strength and elongation of the samples were assessed using the Paramount digital tensile strength tester for textiles, in accordance with the IS 4169 standard test method. Using a template, samples measuring 6x4 ± 0.05 inches were carefully cut from both the warp and weft directions of the fabric. The averages of the five readings obtained from the samples in both the warp and weft directions were then calculated.

Elongation: The ability of a cloth to be stretched, extended, or lengthened is known as elongation. By using the standard test method IS 4169 for tensile strength testing, the elongation was determined to determine the fabric's elongation per cent.

Performance properties

Flexural rigidity, moisture regain, and wickability attributes were investigated to determine the impact of pre treatment procedures on fabric comfort characteristics. Following the common test procedures outlined below, the comfort characteristics of cloth samples were investigated.

Flexural rigidity: The force required to induce a one unit curvature in a flexible structure is commonly referred to as "flexural rigidity," which can also be described as the structure's capacity to resist bending. To estimate the flexural rigidity, the area and weight of the structure were measured.

Moisture regain: Moisture recovery was assessed following the BS1051:1960 standard. Samples of the required size were carefully cut and placed in a dry oven at 105ºC for a duration of three hours, following a preheating period of 10 to 15 minutes to reach the desired temperature. After both the container and the specimen had cooled to room temperature, the sealed container was moved to a desiccator. Following this, the samples were weighed, and an average value was calculated using five readings.

Wickability: Wickability was assessed utilizing the AATCC 1945 standard test method. To measure wicking height, samples measuring 15x2.5 cm were extracted from both the warp and weft directions of the fabric. These samples were pre conditioned at a temperature of 27±2°C and a relative humidity of 65±2 per cent. The wicking height was then computed independently using the average values derived from five readings for each direction of the cotton fabric sample.

Table 1: Preliminary properties of the cotton fabric

Properties	Fabric count (ends and picks/inch)		Weight (g/m^2)	Thickness (mm)
Fabric	Warp/Ends	Weft/Picks		
Grey fabric	49	40	85	0.181

Table 2: Effect of preparatory processes on physical properties of grey cotton fabric

Fabric Physical Parameters		Grey fabric Mean ± S.E	Desized and scoured fabric Mean ± S.E	Per cent change	t-value
Fabric count	Warp	49.00± 0.98	53.10±0.88	+8%	0.07
(ends and picks/square inch)	Weft	40.00± 1.42	44.00±0.33	+10%	0.44
Weight/unit area (g/m2)		85.00± 0.97	98.2±1.24	+16%	0.46
Thickness (mm)		0.181 ±0.09	0.201±0.08	+11%	0.12

RESULTS AND DISCUSSION

Preliminary properties of cotton fabric

Three characteristics, namely fabric count, weight, and thickness, were chosen for the investigation using a medium weight grey cotton cloth. According to the information in Table 1, the grey cotton fabric had a fabric count of 49 ends and 40 picks /inch, 0.181 mm of thickness, and a weight of 85 g/m2.

Effect of preparatory processes on physical properties of grey cotton fabric:

The chosen cotton fabric underwent initial processing steps, including desizing and scouring, which were aimed at eliminating impurities and starch to improve its absorbency for subsequent textile processing. Following desizing, scouring was conducted to thoroughly cleanse the fabric of any remaining contaminants and starch. Subsequent investigations were carried out on the pre treated grey cotton fabric to assess alterations in its geometric, mechanical, and performance characteristics.

Geometrical properties of cotton fabric:

To assess the influence of pre processing techniques on the geometric attributes of grey cotton fabric, properties such as fabric count, weight, and thickness were subjected to testing. According to Table 2, the grey fabric had a fabric count of 49±×40 ±0.88 ends and picks/square inch. The findings showed that the fabric count increased to 53.10± 0.88×44.00± 0.33ends and picks/square inch after desizing and scouring. The fabric count changed by +8 and +10 per cent in the warp and weft directions, respectively, with t-values of 0.07 and 0.44. The increase in fabric count in both the warp and weft directions was found to be statistically insignificant. After desizing and scouring, it was also discovered that the weight and thickness of the grey fabric had increased. The weight of the grey fabric grew from 85.00±0.97g/m2 to 98.2±1.24g/m2, while the thickness of the cloth increased from 0.18±0.09 mm to 0.20±0.08 mm. The thickness and weight of the fabric changed by 16 and 11 per cent, respectively, with t-values of 0.46 and 0.12. Desized and scrubbed fabric's increased weight and thickness were found to be insignificant. Therefore, it is evident from the data in Table 2 that all of the geometrical characteristics of the grey cotton fabric grew non significantly following desizing and scouring.

Mechanical properties of cotton fabric:

The data in Table 3 showed that the bending length of a grey cotton fabric was 2.50±0.34cm and 2.31±0.03cm, respectively, in the warp and weft directions. After desizing and scouring, it was discovered that the bending

Table 3: Effect of preparatory processes on mechanical properties of grey cotton fabric

Fabric physical parameters		Grey fabric Mean ± S.E	Desized and scoured fabric Mean ± S.E	Per cent change	t-value
Bending length (cm)	Warp	2.50±0.34	2.58±0.04	+3%	0.20
	Weft	2.31±0.03	2.46±0.36	+6%	0.48
Tensile strength (k]g)	Warp	22.66± 0.81	21.63±0.56	-5%	0.10
	Weft	22.38±0.99	19.45±0.98	-13%	0.40
Elongation (%)	Warp	23.18±0.28	24.62±1.14	+6%	0.20
	Weft	25.34±0.39	29.04±1.19	+15%	0.38

Table 4: Effect of preparatory processes on performance properties of grey cotton fabric

Fabric Physical Parameters	Grey fabric Mean ± S.E	Desized and scoured fabric Mean ± S.E	Per cent change	t-value
Flexural rigidity (mN. mm)	15.03 ±0.89	16.50 ± 0.78	+10%	0.48
Moisture regain (%)	11.65 ± 1.23	10.56 ±1.02	-9%	0.47
Wickability	3.30 ±0.58	3.60 ± 0.65	+9%	0.36

length increased to 2.58±0.04 cm and 2.46±0.36 cm, respectively, with increases of 3 and 6 per cent and 0.20 and 0.48 t-values. At the 1 per cent significance level, a notable increase in bending length (weft direction) was observed for the desized and scoured cotton cloth. Following the desizing and scouring process, the tensile strength of the grey cotton fabric decreased to 21.63±0.56 kg in the warp direction and 19.45±0.98 kg in the weft direction, as indicated by t-values of 0.10 and 0.40, respectively. This resulted in a decrease of 5 per cent in the warp direction and 13 per cent in the weft direction. The findings indicated that there was no statistically significant difference between the decrease in tensile strength of desized and scrubbed cotton fabric in the warp and weft directions. After the desizing and scouring process, the untreated grey cotton fabric exhibited enhanced elongation in both the warp and weft orientations, as indicated by t-values of 0.20 and 0.38. It was noted that the elongation of the grey cotton fabric, which had undergone desizing and scouring, exhibited an increase of 6 per cent in the warp direction and 15 per cent in the weft direction. It grew from 23.18±0.28 and 25.34±0.39 per cent to 24.62±1.14 and 29.04±1.19 per cent. In both the warp and weft orientations, it was discovered that the desized and scrubbed grey cotton fabric's increased elongation was not substantial. As a result, the desized and scrubbed grey cotton fabric's tensile strength and elongation did not suffer considerably.

Performance properties of cotton fabric:

Flexural rigidity, moisture recovery, and wickability tests were conducted to determine how the preparation techniques affected the comfort characteristics of cotton fabric. Data in Table 4 showed that grey cotton fabric's flexural stiffness rose as well. It was initially measured at 15.03±0.89 mN.mm, but after desizing and scouring, the value climbed to 16.50±0.78 mN.mm with a 10 per cent rise and a 0.48 t-value. The findings indicated that the desized and scrubbed grey cotton fabric's increase in flexural stiffness was not significant. The desized and scrubbed grey cotton fabric's air permeability decreased, although not much. Gray cotton cloth has a moisture regain of 11.65±1.23 per cent. After desizing and scouring, it was discovered that the moisture regain dropped to 10.56±1.02 per cent; the per cent reduction was 9 per cent with a 0.47 t-value. As a result, the moisture recovery of the desized and scrubbed grey cotton fabric reduced non significantly. Gray cotton cloth was determined to have a wickability of 3.30±0.58 cm. The wickability of grey cotton fabric increased to 3.60±0.65 cm with an increase of 9 per cent and 0.36 t-value after desizing and scouring.

CONCLUSION

To eliminate impurities and starch from cotton fabric, pretreatment procedures like desizing and scouring were employed. Following these treatments, the geometric properties of the pre treated fabric showed enhancement. After the desizing and scouring processes, there was a modest increase in fabric count, with an 8 per cent improvement in the warp direction and a 10 per cent improvement in the weft direction. Additionally, the weight of the fabric increased (16%) and the thickness increased (11%). The variations in tensile strength were determined to be statistically insignificant, while there was a increase in elongation in the weft direction (15%) and increase in the warp direction (6 %). The warp (6.1%) and weft (11.4%) bending lengths increased, while the flexural stiffness went up by ten per cent. There was a sizable change in weft orientation and bending length. Specifically, moisture recovery reduced by (9%), but wickability improved by (9%). The differences were discovered to be insignificant. As a result, it was determined from the test findings that preparation techniques had an impact on the physical characteristics of cotton fabric.

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Received for publication : August 21, 2023
Accepted for publication : September 9, 2023