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Analysis of Physical Properties of Pre Treated Cotton Fabric for Dyeing Process

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ABSTRACT

Cotton is the most important and widespread natural fiber for textile industry in the world. Mostly textile products are made of cotton in the form of apparel, home textiles, and industrial products. Cotton as all agriculture crops is also dependent on the climate conditions, soil quality, and water in which it is cultivated. All of these factors contribute to the diversity of cotton fiber properties. Mostly cotton fabric manufactured in gray form, so that the pre treatment of cotton fabric before dyeing and finishing predominantly involves a combinations of desizing and scouring processes. The physical properties of the cotton fabric were analyzed after desizing and scouring process. The study results indicate that all geometric attributes of cotton fabric, including fabric count, weight/unit area, thickness, tensile strength, bending length and elongations. The study revealed that desizing and scouring of the cotton fabric led to an enhancement in wickability and flexural rigidity, while simultaneously reducing moisture regain.

Keywords: Cotton, Pretreatment, Desizing, Scouring, Wickability, Moisture regain, Flexural rigidity

INTRODUCTION

Cotton is one of the most widely used materials and has a pre-eminent position among other materials used in textile and clothing. In order to obtain a functional cotton fabric, grey cotton fabric goes through a series of wet chemical treatments, such as desizing, scouring and bleaching, to remove hydrophobic impurities and other dust materials and make the fabric ready for colouration and other finishing process (Reena *et al*., 2021). Although the conventional wet treatment is useful for preparing cotton material for further treatments. The main problems of large amounts of water and chemicals usage exist after wet processing. Recently, cost efficiency and environmental protection have become important considerations. As a result, the textile industry is seeking for a more cost efficient and environment friendly cotton preparation techniques as an alternative to the conventional wet chemical processing (Ebrahimi *et al.,* 2011).

Cotton, being famous for its purity and user friendly properties is the principle clothing material of the world. It is universally known that this fibre absorbs and releases perspiration quickly thus keeping the body temperature cool and balanced. It being cellulose by nature, possesses the most advantageous characteristics like excellent wicking, good conductor, graceful drapability and user friendly to the wearer (Kurlageri, 2009). According the Memon *et al*. (2020) cotton is the most important and widespread natural textile fibre in the world among all synthethic and natural fibres. Across 75 countries, the production of cotton crops provides income for more than 250 million people. Approximately, half of all the textile products are made of cotton in the form of apparel, home textiles and industrial products. Quality of Cotton fibres is dependent on the climate conditions, soil quality, and water in which it is cultivated. All of these factors contribute to the diversity of cotton fibre properties. To

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enhance biodiversity and to maintain biological cycles, organic cotton can play an important role.

Pretreatment is a process for prior fabric dyeing and finishing which involves desizing and scouring. The objective of desizing and scouring is to produce fabrics which are free from added and natural impurities. The nature of impurities are depend on the nature of fibre from which the fabric has been made. The added impurities present on cotton fabric are dust, oil stains and size (Karhan *et al*., 2008). One of the important steps is scouring, in which the complete or partial non-cellulosic compounds found in cotton are removed, as well as impurities such as machinery and size lubricant (Barsa and Malik, 1984; Freytag and Donze, 1983). There were various physical properties such as geometrical, mechanical and comfort properties. The geometrical properties of the cotton fabric comprised of fabric count, weight and thickness etc. Mechanical properties includes tensile strength and elongation. Comfort properties includes bending length, flexural rigidity, moisture regain and air permeability of fabric. So that the aim of this research work was to investigate the influence of pretreatment of cotton fabric on physical properties. Physical properties of fabric are vital because these properties decide the functionality of the fabric.

METHODOLOGY

Selection of raw material:

Three samples of grey cotton fabric having medium weight were collected from local market of Hisar, Haryana, India. The pure cotton fabric which was considered the most suitable for apparel purpose was selected by advisory committee members from the major subject. To confirm the purity of the cotton fabric, burning, microscopic and chemical tests were conducted.

Method of pre-treatment:

Desizing:

It is the process in which the sizing material is removed to facilitate the penetration of dyes and chemicals in the subsequent wet operations".it helps to removes the added sizing material by acid assisted hydrolysis. As presence of any sizing materials like starch, polyvinyl alcohol and guar gum could hinder uniform dyeing of textile. The fabric was weighted and pre wetted prior to introducing into the desizing bath. The fabric was squeezed thoroughly and was treated in a bath containing 0.5 per cent sulphuric acid, 0.5 per cent wetting agent (Ultravon JU) on the weight of fabric with MLR 1:30. It was kept at 600 temperature for 60 minutes with occasional stirring. After required time, the fabric was taken out, washed thoroughly with water and dried (Jose *et al.*, 2016).

Scouring*:*

It is the method of removes the adhered as well as added fatty matter present in the textile material by saponification process. 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. These impurities are mainly acidic in nature and can be easily removed by hot alkaline solutions". The acid desized fabric was initially weighted and soaked in water. It was then entered into the scouring bath containing required amounts of sodium carbonate (2.0%), sodium hydroxide (5.0%) and wetting agent (0.5%) on the weight of the fabric with MLR 1:20. The temperature of the bath was gradually raised to 900 C and fabric was treated for 60 minutes. The scouring was continued for 1 hour with occasional stirring. The scoured fabric was then washed with water, neutralized with weak acetic acid solution and dried at ambient temperature (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.

Fabric count:

Fabric count is the number of warp (ends) and weft (picks) yarns per inch in a woven fabric. Paramount pick glass with pointer was used to determine the fabric count using ASTM-D123 standard test method. It was measured by "counting the number of threads in per square inch in warp and weft directions at five different places in the fabric." An average of five readings was taken.

Fabric weight:

"The weight of fabric is defined as weight of a

known area of the material and then computing the weight per unit area". Samples were cut at random from fabric with the help of round cutter for GSM. The samples were weighted separately on the Paramount Precision Scale for grams per square meter using ASTM-D 3776-90 test method. An average of five readings was taken and weight per unit area in grams per square meter was calculated.

Fabric thickness:

"Fabric thickness is defined as the distance between upper and lower surfaces while exerting a specified pressure on the material by the pressure foot of the tester". Paramount thickness tester was used to determine the thickness of the fabric using ASTM D1777- 60 test method. A specimen was placed on the flat surface below pressure foot of the instrument free from folds, crushing or distortion and wrinkles. The pressure foot was lowered upon the specimen gently until the pointer of the dial meter stopped moving further and the reading on digital gauge was recorded in mm. An average of five readings was calculated as the fabric thickness.

Mechanical properties of Cotton fabric:

The mechanical properties *i.e.* Bending length, tensile strength, elongation, crease recovery angle, moisture regain and wickability of selected cotton fabric was evaluated before dyeing of the cotton fabric.

Bending length:

Cotton fabric samples of size 25 x 200 mm were cut from warp and weft directions with the aid of template and conditioned. Both template and samples were transferred to the platform with the fabric underneath, coinciding the zero mark of the scale and zero line engraved on the side of the plate form. The template was moved slowly over 41.50 slope along with the strip till the top of the specimen viewed in the mirror cut in between both index lines. The bending length for both directions was read from the scale, which coincided with the front edge of the top plate. Each sample was tested five times at each edge.

Tensile strength:

The samples of size 6x4 ± 0.05 inches were cut out from warp and weft directions of the fabric with the help of template. The samples were mounted between the jaws with approximately 1.5 inch of fabric protruding from each side of the jaws at a distance of 3 inches. The speed of upper jaw was adjusted at 300±10mm/min. The machine was started and the upper jaw moved in upward direction. The readings were taken from the digital display at sample break. The samples were slightly tensioned for getting accurate elongation at break. Five readings of the samples from both the directions (warp and weft) were taken and the averages were calculated.

Elongation:

Elongation is the ability of the fabric to be stretched, extended or lengthened. Elongation of the fabric measured along with tensile strength through the digital monitor screen fitted on the tensile strength tester which gives elongation reading along with tensile strength of the fabric. The elongation was measured to calculate the elongation percent of the fabric by following the standard test method IS 4169 used for tensile strength testing.

Crease recovery angle:

Samples of cotton fabric were cut both in warp and weft directions from the fabrics with a template measuring 0.5 cm x 2.5cm and were tested after conditioning. The test specimen was carefully creased by folding in half and was placed between the two glass 30 – plates. The specimen was creased for 3 minutes under 2 kg weight. The specimen was removed and transferred to the fabric clamp in the instrument and allowed to recover from the crease for 3 minutes. As it recovers, the dial of the instrument was rotated to keep the free edge of the specimen in line with the knife-edge. The recovery angle in degree was noted from the engraved scale. Warp and weft way recovery was observed separately to the nearest degree from the mean values of the five readings in each direction.

Moisture regain:

Moisture regain was measured using BS1051:1960. The amount of moisture in a sample of material may be expressed in terms of regain of moisture content. The oven dry weight is defined as the constant weight obtained by drying at a temperature of 105±3^{0}C. The oven was preheated for 10-15 minutes to reach the controlled temperature and the samples were placed in dry oven at 105±3^{0}C for 3 hours. The closed container was transferred to desiccator when the container and the specimen were kept at room temperature. The samples were weighed and an average mean of five readings

was calculated. The percentage of moisture regain was calculated using the following formula:

Percentage moisture regain = Original weight- oven dry weight/oven dry weight x100

Wickability:

The wickability was determined using AATCC 1945 standard test method. For evaluation of wicking height, samples of size (15x2.5cm) were cut from warp and weft direction of the fabric, pre-conditioned at 27±2°C at 65±2 percent relative humidity and suspended vertically in a stand in such a manner that its lower end immersed in a reservoir of distilled water. The height reached by the water in the fabric above the water level in the reservoir of distilled water at a constant time duration of 2 minutes was measured and recorded. The wicking height was calculated separately from the mean values of the five readings of each direction for control, scoured, biomordant treated and treated dyed samples.

RESULTS AND DISCUSSION

Preliminary properties of cotton fabric:

Medium weight grey cotton fabric was selected for the study. The selected cotton fabric was desized and scoured, resultant fabric was evaluated for three different parameters *i.e.* fabric count, weight and thickness. The data in Table 1 showed that the fabric count of cotton grey fabric was 51x40 ends and picks/sq. inch in warp and weft direction with 0.17 mm thickness and 84 g/m^2 weight, respectively.

Geometrical properties of cotton fabric after treatment:

The data in the Table 2 depicts that the fabric count of scoured fabric was 54 ends and 44 picks per square inch and desized fabric was 59 ends and 46 picks per square inch. The fabric weight of the scoured fabric was 98.2 g/m^2 and desized fabric was 99g/m^2. Thickness of scoured fabric was 0.31mm and desized fabric was 0.30mm, respectively.

Mechanical properties of cotton fabric:

The data in the Table 3 depicts that the bending length of grey cotton fabric was 1.78±0.02cm and 1.97±0.03cm, respectively, in the warp and weft direction. After desizing and scouring, it was discovered that the bending length increased to 1.82±0.01cm and 2.05±0.04cm, respectively, t-values (0.19 warp and 0.43 weft) and C.V. percentage (4.56% warp and 5.76% weft). The flexural rigidity of grey fabric was 17.34±0.92 mg-cm and increased in case of scouring *i.e.* 18.23±0.84 mg-cm and the t-value was 0.36. After desizing and scouring process on fabric the tensile strength was

Table 1 : Preliminary properties of cotton fabric

Properties	Fabric count (ends and picks/sq. inch)		Weight (g/m^2)	Thickness (mm)
Fabric structure	Warp/Ends	Weft/Picks		
Grey fabric	51	40	84	0.17

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

Samples of cotton fabric	Fabric count (ends and picks/sq. inch)		Weight (g/m^2)	Thickness (mm)
	Warp/Ends	Weft/Picks		
Desized	59	46	99	0.30
Scoured	54	44	98.2	0.31

Table 3 : Effect of preparatory process on mechanical properties of cotton fabric

Mechanical Properties	Fabric structure	Grey fabric Mean±SE	Desized and Scoured fabric Mean±SE	t-value	C.V.
Bending length (cm)	Warp	1.78±0.02	1.82±0.01	0.19	4.56
	Weft	1.97±0.03	2.05±0.04	0.43	5.76
Flexural rigidity (mg-cm)		17.34±0.92	18.23±0.84	0.36	
Tensile strength (kg)	Warp	23.53±0.78	22.67±0.72	0.11	9.89
	Weft	22.25±0.99	22.04±0.97	0.45	8.87
Elongation (%)	Warp	23.45±1.28	24.76±1.35	0.20	13.43
	Weft	25.43±1.36	27.67±1.56	0.40	10.67

Table 4 : Effect of preparatory process of performance properties of cotton fabric

Performance properties	Grey fabric Mean	C.V.	Desized and scoured fabric Mean	t-value
Crease recovery angle (degree)	105.99	2.35	104.87	0.56
Moisture regain (%)	9.56	2.31	8.97	0.43
Wickability (cm)	3.30		3.56	0.36
Water Absorbency	<10 sec		<11sec	-

22.67±0.72 kg and 22.04±0.97 kg, respectively, in the warp and weft direction. Before scouring the grey fabric tensile strength was 23.53±0.78 kg and 22.25±0.99 kg, respectively, in the warp and weft direction and the t-value was found 0.11 and 0.45. The C.V. percentage was showed 9.89. the percentage of elongation of the grey fabric was 23.45±1.28 and 25.43±1.36 in the warp and weft direction. After pre-treatment process the elongation was increased 24.76±1.35 and 27.67±1.56 % in warp and weft direction. The t-value was 0.20 and 0.40, and C.V. percentage was 13.43 and 10.67, respectively. As a result, the desized and scoured grey fabric showed that tensile strength and elongation did not effect considerably.

Performance properties of cotton fabric:

The data depicts in Table 4 that crease recovery, moisture regain, wickability and water absorbency and their effect on pre-treated fabric. The table narrates that the crease recovery angle of scoured fabric was decreased 104.87 from the grey fabric *i.e.* 105.99 with C.V. percentage and t-value was 2.35 and 0.56, respectively. The moisture regain of scoured cotton fabric was also decreased 8.97 per cent with C.V. was 2.31 percentage as compared to the grey fabric was 9.56 percent and t-value was 0.43. The effect of wickability on scoured cotton fabric was found 3.56 cm as grey fabric was 3.30 cm with t-value was 0.36. The moisture regain after the drop test indicated the scoured fabric was <11 sec increased as compared to grey fabric (<10 sec). The results shows that the desized and scoured cotton fabric was found suitable for dyeing and better dye penetration.

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 modest increased in the fabric count, fabric weight and the thickness in warp and weft both direction, respectively. Following the mechanical properties of the cotton fabric the banding length was increased from the grey fabric in warp direction was from 1.78 to 1.82 cm and in weft direction was from 1.97 to 2.05 cm. Flexural rigidity was also increased from 17.34 to 18.23 mg-cm. After desizing and scouring the tensile strength was increased in both direction warp and weft from 23.53 to 22.67 kg and 22.25 to 22.04 kg, respectively. After that the elongation was also increased in warp and weft direction was 23.45 to 24.76 % and 25.43 to 27.67 %, respectively. Following the performance properties of desized and scoured fabric was decreased of crease recovery angle and moisture regain was 105.99 to 104.87 degree and 9.56 to 8.97 %, respectively. Wickability was increased from 3.30-3.56 cm after desizing and scouring the cotton fabric. 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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