



Effects of Jute Fibres Percentage Variation on Cotton-Jute Blended Fabric: Evaluation of Blended Fabrics After Dyeing Process

Md. Solaiman^{1,*}, Khairul Islam¹, Sanoar Hossain¹, Moshir Rahman¹, Mahfuz Alam¹,
Ataur Rahman¹, Abul Kasem Mohammed Fazlul Haque²

¹Department of Fabric Manufacturing Engineering, Textile Engineering College, Noakhali, University of Textiles, Dhaka, Bangladesh

²Department of Yarn Manufacturing Engineering, Textile Engineering College, Noakhali, University of Textiles, Dhaka, Bangladesh

Email address:

solaimanbari@gmail.com (Md. Solaiman), tex.khairul@gmail.com (K. Islam), sanowarnipun@gmail.com (S. Hossain),

moshiurtex97@gmail.com (M. Rahman), mas.shojib@gmail.com (M. Alam), akmfazlulhaque1@gmail.com (A. K. M. F. Haque)

*Corresponding author

To cite this article:

Md. Solaiman, Khairul Islam, Sanoar Hossain, Moshir Rahman, Mahfuz Alam, Abul Kasem Mohammed Fazlul Haque. Effects of Jute Fibres Percentage Variation on Cotton-Jute Blended Fabric: Evaluation of Blended Fabrics After Dyeing Process. *International Journal of Industrial and Manufacturing Systems Engineering*. Special Issue: *Manufacturing Strategy for Competitiveness*. Vol. 4, No. 6, 2019, pp. 64-70.

doi: 10.11648/j.ijimse.20190406.12

Received: September 16, 2019; Accepted: October 15, 2019; Published: December 18, 2019

Abstract: In this study, two fabrics were collected from jute research institute, Bangladesh consisting of 80% Jute & 20% cotton yarn; 50% Jute and 50% Cotton yarn by weight, to make comparison between the samples. The tearing strength (TS), drape coefficient, Pilling resistance, Color fastness to wash & rubbing, water take up% and Color strength were investigated. From analyzed data, it was found that tearing strength in warp and weft way direction is higher for 80% jute and 20% cotton blended fabric. From results it was seen that in warp direction, tearing strength for 80% and 20% cotton blended fabric is 4% higher than 50% jute and 50% cotton blended woven fabric but in weft direction 356% higher for 80% jute and 20% cotton blended woven fabric. Color fastness to rubbing is comparatively better for 50% jute and 50% cotton blended sample. Wash fastness property is almost same for both blended samples. But jute prominence sample carried poor wash fastness property on blended cotton and polyamide in compare equally blended sample. Moderate pills are formed on 50% cotton and 50% jute blended fabric and slight surface fuzzing and/ or partially formed pills on 80% jute and 20% cotton blended sample. Drape resistance property is better for jute prominence blended fabric. Color strength is almost same for both samples.

Keywords: Cotton, Jute, Woven Fabric, K/s Value, Reactive Dye

1. Introduction

Fabric or cloth is the second basic needs of human being after food. Since the beginning of civilization weaving of cloth has been carried out in one form or the other by people of many countries. A woven cloth consists of two sets of yarns, namely warp and weft. The yarns that are placed lengthwise or parallel are called warp yarns and the yarns that run crosswise are called weft yarns [1].

In recent times, various types of woven fabrics are observed throughout the market place. It varies from styles, designs, compositions, structures, etc. To develop the criteria and quality of woven fabrics, blends of two or more types of fibre

are used. A fabric which is produced from the blended yarn might have better characteristics than what could be obtained in a fabric produced from a single fiber.

Jute is one of the world's most important fibrous crops, being exceeded in quantity only by cotton. It has long been known to people as a golden fiber. Jute fiber is a bast fiber obtained from the bark of jute plant containing three main categories of chemical compounds namely cellulose (58~63%), hemicellulose (20-24%) and lignin (12~15%), and some other small quantities of constituents like fats, pectin, aqueous extract, etc. Jute fiber is composed of small units of cellulose surrounded and cemented together by lignin and hemi-cellulose [2].

Cotton is a soft, fluffy white staple fiber which grows in a boll or protective case, around the seeds of the cotton plants of the genus *Gossypium* in the mallow family *Malvaceae*.

In the present work, a few characteristics of jute-cotton blended fabrics have been evaluated. Fabric produced from the blended yarn might have better characteristics than what could be obtained in a fabric produced from a single fiber. The blending of cotton is done to develop drape properties, comfortability, durability, dyeability and many other properties of the fabric products. Any successful attempt to blend jute fiber with cotton would be a breakthrough in the field of textile [3].

Blending jute with cotton fiber may be an acceptable way of jute diversification by which value added products can be produced. Jute fibers have several advantages like a lustrous golden appearance, high tenacity and good properties. Hence the techniques of blending and softening could as utilized to upgrade the quality of jute and thus form a new class of jute-based fabrics having an expanding market within and outside the country [4].

As jute is an available and cheap fibre, it may be provide a great support to our national economy to reduce raw materials import cost of fabric. Jute-Cotton blended fabric may also lead to environmental awareness because of having environmental friendly characteristics of Jute. To develop better quality of fabric and reduce production cost by using jute cotton blended yarn as a raw material is a very much beneficial suggestion for upcoming decades.

2. Materials

For this experiment two samples of Cotton –Jute blended woven plain fabrics were used where one sample have cotton and jute percentage were 20% and 80% respectively and another have 50% jute & 50% cotton respectively. The final target of this work is to analysis the effect of jute fibres percentage variation on cotton-jute blended fabric. Samples were collected from Bangladesh jute Research Institute. The samples (2/2 Plain structure and 1/1 Plain structure) weighs were 465 gm/m² and 230 gm/m² respectively with warp density 86 ends/inch & 49 ends/inch respectively and weft density 25 picks/inch & 39 picks/inch respectively. Fastness Tester, Beesley's balance, Light fastness Tester, Crocking meter, Stop watch, crease recovery tester, Tensile and Tearing strength tester and Spectrometer were used to do the physical, mechanical and visual properties of the fabrics.

3. Methods of the Experiments

3.1. Scouring and Bleaching Procedure of Blended Fabric

Set the bath with substrate at room temperature with wetting agent, soda ash & NaOH. Then added sequestering agent and raised the temperature to 100°C. After reaching 100°C temperature added stabilizer, H₂O₂ and run 45 minutes at the same temperature. After that cooled the bath and then drain out water with ingredients. Then rinsed the samples two

times with hot and cold water respectively. Finally treated the samples with a peroxide killing agent for 10 minutes to remove the residual peroxide and then rinsed the samples with cold water again.

3.2. Dyeing Procedure of Blended Fabric

Jute fibre has a special affinity to basic dyestuff but cotton fibre has a great affinity to reactive dyes for better fastness properties. For this reason, the specimens are dyed with basic dye and reactive dye. To increase the affinity of cotton towards basic dye, mordanting was done.

3.3. Mordanting Process

Dye bath was set at room temperature, then raised the temperature at 100°C. Then tannic acid was added and reduced the temperature, and fixed temperature at 60°C and run the machine for 2 hours and then drained out the liquid. After mordanting, fixation was done. For fixation tartaric acid was added at room temperature and run the machine for 30 minutes and dropped the liquor and rinsed the samples.

3.4. Basic Dye Application Procedure to Specimen

Firstly, made paste by adding water, wetting agent and acetic acid with dyes; then added hot water and stirred to make desirable dye solution. Set the dye bath with substrates at room temperature. Added 1/3 of total amount of paste to the bath at 25°C and run the bath 15 minutes. Then raised the temperature 40°C, again added 1/3 of total paste and run the machine for 20 minutes. After that 1/3 of remaining paste is added at 70°C and run the machine for 25 minutes. Then cooled the bath and drained out liquor.

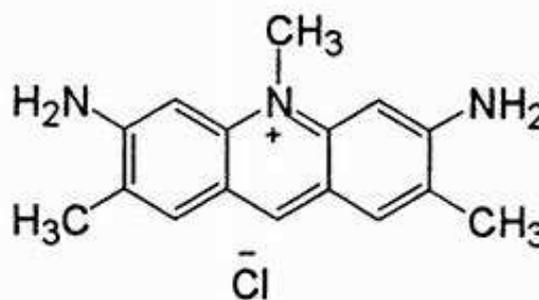


Figure 1. Chemical structure of basic dye.

3.5. Reactive Dye Application Procedure to Specimen

Set the dye bath with substrate at room temperature. Added wetting agent, Sequestering agent, leveling agent and dye at room temperature and raised the temperature to 80°C. Run the bath for 10 minutes then added half of total Glauber salt and after 10 minutes residue half portion of salt was added. After that Soda ash was added at the same temperature in two stages and then run the machine for 25 minutes. Dropped the liquor and rinsed two times by cold and hot wash with soap and soda.

4. Testing and Analysis

4.1. Testing Procedure Tear Strength (ISO 13937-2 & ASTM D1424)

Cut the samples (80cm×58 cm) according to the template from left, middle and right. Place the pendulum at the notch point and put the samples in the jaw and clamp it (80 mm is parallel to horizontal & 58 mm is vertical direction). Notch the sample by sharp knife (15mm). Release the pendulum by depressing pendulum stop point to sewing a full cycle for tearing the fabric before releasing the stop button. [5].

4.2. Testing Procedure Colorfastness to Rubbing (ISO 105X12; 1993; BS EN ISO 105X12; 1995)

Test Specimen:

Two pieces 14cm x 5cm specimens are required for dry rubbing and two for wet rubbing.

Test Procedure:

Dry Rubbing Test:

Lock the test specimen onto the base of the Crock meter so that it lies flat and taut for test and taut for testing. Using the spiral clip, set a 5cm×5cm square of the white cotton, rubbing test cloth to set the finger of the Crockmeter. Lower the covered finger. Turn the hand crank and make ten complete turns of the crank, at the rate of one turn per second. Remove rubbing test specimen cloth from the finger and evaluate colour transfer using the gray scale for staining under standard lighting, D65. One test is done to warp /wales direction and another for weft / course direction. [6, 7]

Wet Rubbing Test:

Repeat the procedure on another sample with the white test cloth wetted in distilled water. Ensure that the rubbing test cloth will be wetted with water to 100% take up. Air dries the cotton-jute blended test cloth at the room temperature before evaluation.

4.3. Testing Procedure of Color Fastness to Washing (ISO 105 C06)

Collect the samples (10cm×4cm) from bulk and then conditioning for 04:30 hours to 06 hours. Make a specimen of 4 cm x 10 cm in size. Sew the specimen with multi-fiber fabric (10cm×4cm) of same size at one corner. Make the solution of 4gm/litre ECE detergent & 1 gm/litre sodium perborate. Put the specimen with multi-fibre fabric into the solution in Rotary washing m/c and taking temp: 60°C at 30 min with 25 pcs still ball. Rinse with hot water respectively. Squeeze with cold water of the sample is done (Hand Wash). Then drying is done at a temperature in the air not exceeding 60°C. The stitching is then broken out except on one of the shorter end. Measure the staining and color change by grey scale & make a test report. [8]

4.4. Testing Procedure of Pilling Test (ICI Pilling Box) (ISO 12945-1)

The sample (5" x 5") is sewn so as to be firm fit when placed a rubber tube 6" long, 1.25" outer diameter and 0.125"

thick. The cut ends of the fabric are covered by cellophane tape and 4 tubes are placed in a box (9"x 9" x 9") lined with cork 0.125" thick. The box containing the tube is then rotated at 60 rpm for 5 hours. After tumbling, the extent of pilling assessed visually comparison with the arbitrary standards. [9]

4.5. Testing Procedure of Drape Co-efficient (ISO 9073-9: 2008)

Test Specimen:

Make samples at a dimension of 30 cm diameter.

Test Procedure:

In the check a circular specimen is command concentrically between 2 smaller horizontal discs and is allowed to drape into folds beneath its own weight. A light-weight is shone from beneath the specimen and also the shadow that the material casts, is copied onto aringed piece of paper identical size because the unsupported a part of the material specimen. To measure the areas concerned, the total paper ring is weighed then the shadow part of the ring is cut away and weighed. The paper is assumed to possess constant mass per unit spaceso the measured mass is proportional to space. [10]

4.6. Testing Procedure of Color Strength

The colour intensities of 50% Jute & 50% Cotton blended woven fabric and 80% Jute & 20% Cotton blended woven fabric for a specific design and construction, fabrics are measured and compared using a UV VIS-NIR reflective spectrometer (Spectra Flash SF 600 X, USA), over the range of 360 nm to 700 nm.[11, 12]

4.7. Testing Procedure of Water Takes Up Percentage (ASTM D-570)

Test Specimen:

Make a sample at a dimension of 2 cm in length x 1 cm in width.

Test Procedure:

Samples were immersed in a beaker containing 100ml of deionized water at room temperature for 1 hour. Initially, weight of samples was determined, after certain time interval; samples were taken out of the beaker and wiped using tissue papers. Their weight was taken again. In this case, it shows no uptake after 40 minutes; that why carried out the test upto 1 hour water uptake percentage was determined by using following equation-

Water up-take = $[(\text{Wet weight} - \text{Dry weight}) / \text{Dry weight}] \times 100$ [12, 13]

5. Results and Discussion

5.1. Determination of Tearing Strength

The Elmendorf tear test determines the tearing strength by measuring the work done in tearing through a fixed length of the test specimen. It is usually measured in kN/m or pounds (lbf).

As it can be seen from Figure 2, that tearing strength for warp way direction of 80% Jute & 20% Cotton blended

woven fabric is greater than 50% Jute & 50% Cotton blended woven fabric after dyeing. From Figure 3, it is also seen that tearing strength for weft way direction of 80%.

Jute & 20% Cotton blended woven fabric is many times

higher than 50% Jute & 50% Cotton blended woven fabric. The strength of Jute is greater than Cotton. For this reason 80% Jute & 20% Cotton blended woven fabric possess a high tearing strength.

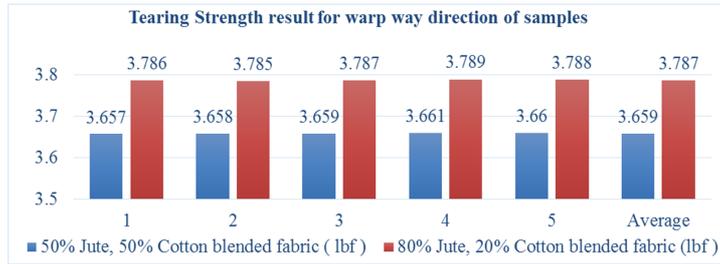


Figure 2. Tearing strength results in warp way direction of samples.

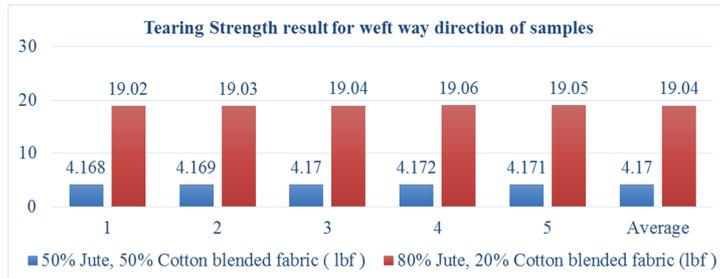


Figure 3. Tearing strength results in weft way direction of samples.

5.2. Determination of Colorfastness to Rubbing

From table 1, compare the contrast between untreated and treated white rubbing cloth with the staining Grey Scale and rate from 1 to 5 and changing in the tested specimen with changing Grey Scale. This test is designed to determine the degree of colour which may be transferred from the surface of a coloured fabric to specify test cloth for rubbing (which could

be dry and wet). From the both samples, it is seen that amount of staining moderate at dry condition and at the wet condition, the amount of staining is higher than dry condition rubbing. As basic dyes are poor to moderate fastness properties, so the rubbing fastness of 50% Jute & 50% Cotton blended woven fabric is better than 80% Jute & 20% Cotton blended woven fabric.

Table 1. Colorfastness to rubbing results for specimens.

Dry condition Rubbing result			Wet condition Rubbing result	
Sl. No	50% Jute & 50% Cotton blended woven fabric	80% Jute & 20% Cotton blended woven fabric	50% Jute & 50% Cotton blended woven fabric	80% Jute & 20% Cotton blended woven fabric
1	4	3-4	3	2-3
2	4	3	2-3	2-3
3	4-5	3-4	3	2-3
Average	4	3-4	3	2-3

5.3. Determination of Color Fastness to Washing

From the tables 2 and 3, it is found that dyes stained on the fibres of the multifibre fabric show the rating are almost same for both fabrics. The staining on the di-acetate, nylon, polyester, acrylic, wool for 50% Jute & 50% Cotton blended woven fabric is found in good rating value that is 4

to 5, which shows moderate staining and for bleached Cotton, staining rating is 2-3 which indicate lower staining. In case of 80% Jute & 20% Cotton blended woven fabric, the staining rating for Di-acetate, Polyester, Acrylic and wool are moderate and for Bleached Cotton and Polyamide rating is 2-3 i.e. lower staining because of prominence of jute is higher.

Table 2. Results of Color Fastness to wash of 50% Jute & 50% Cotton blended woven fabric.

Multifibre's layer	Sample 1	Sample 2	Sample 3	Average
Di-acetate	4	4	4	4
Bleached Cotton	3	2-3	2-3	2-3
Polyamide	3-4	4	4	3-4
Polyester	4-5	4-5	4-5	4-5
Acrylic	4-5	4-5	4-5	4-5
Wool	4	4	4	4

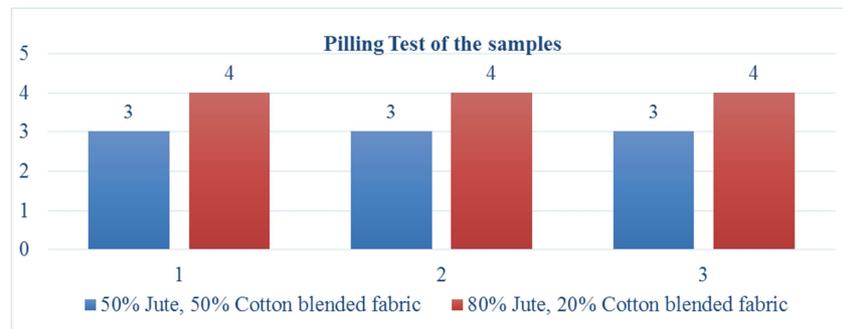
Table 3. Results of Color Fastness to wash of 80% Jute & 20% Cotton blended woven fabric.

Multifibre layers	Sample 1	Sample 2	Sample 3	Average
Di-acetate	4	4	4	4
Bleached Cotton	2 - 3	2 - 3	3	2 - 3
Polyamide	2 - 3	3	2 - 3	2 - 3
Polyester	4 - 5	4 - 5	4 - 5	4 - 5
Acrylic	4	4	4	4
Wool	3 - 4	4	3 - 4	3 - 4

5.4. Determination of Pilling Resistance

Pilling is a fabric surface characterized by little pills of entangled fiber clinging to the cloth surface and giving the garment unsightly appearance. The pills are formed during wear and washing by the entanglement of loose fibers which protrude from the fabric surface. Pilling resistance property for the treated and untreated sample is remaining almost unchanged.

From figure 4, it is seen that the rating of pilling is 3, which indicate moderate surface fuzzing or moderate pilling for 50% Jute & 50% Cotton blended woven fabric and for 80% Jute & 20% Cotton blended woven fabric rating is 4, which indicate slight surface fuzzing or partially formed pills. The higher percentage of small projecting fibre presents in 50% Jute & 50% Cotton blended woven fabric is reason behind this variation of pilling.

**Figure 4.** Results of Pilling resistance of the samples.

5.5. Determination of Drape Co-efficient of Samples

The drape is measured as the drape co-efficient which is the ratio of Total mass of paper ring to Mass of shaded area expressed in percentage i.e.

Drape co efficient = (Total mass of paper ring / Mass of shaded area) x 100%. From tables 4 and 5, it is clear that drape co efficient of 80% Jute & 20% Cotton blended woven fabric

is higher than drape co efficient of 50% Jute & 50% Cotton blended woven fabric. It is known that the higher drape co efficient, lower the drape ability of the fabric. So, 50% Jute & 50% Cotton blended woven fabric possess lower drape resistance than 80% jute and 20% cotton blended samples. This is due to jute fibre process higher strength than cotton fibre.

Table 4. Results of drape co efficient of 50% Jute & 50% Cotton blended woven fabric.

Total mass of paper ring	Mass of shaded area	Drape co efficient	Average
4.38	2.85	65.07%	
4.39	2.86	65.15%	65.15%
4.39	2.87	65.36%	

Table 5. Results of drape co efficient of 80% Jute & 20% Cotton blended woven fabric.

Total mass of paper ring	Mass of shaded area	Drape co efficient	Average
4.39	3.28	74.72%	
4.38	3.27	74.66%	74.70%
4.39	3.28	74.72%	

5.6. Results of Colour Measurement

Color strength of sample 50% Jute & 50% Cotton blended woven fabric and 80% Jute & 20% Cotton blended woven fabric are measured through K/S value. When reflectance is more, absorbance is less which indicates the K/S value is less.

On the other hand when reflectance is less; absorbance is more, indicates the more K/S value. K/S value was measured in 360nm-700nm wave lengths. For 50% Jute & 50% Cotton blended woven fabric value of K/S is 4.669 at 360nm and 4.425 at 700nm. For 80% Jute & 20% Cotton blended woven fabric K/S was 4.4770 at 360 nm and 4.435 at 700 nm wave length.



Figure 5. K/s value for 50% Jute & 50% Cotton blended woven fabric.

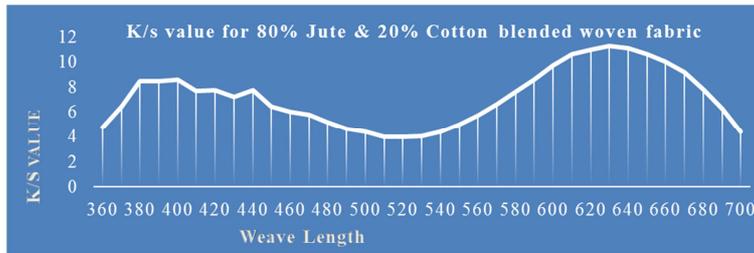


Figure 6. K/s value for 80% Jute & 20% Cotton blended woven fabric.

5.7. Determination of Water Takes Up Percentage

From tables 6 and 7, it is seen that water take up % for 50% Jute & 50% Cotton blended woven fabric is greater than 80% Jute & 20% Cotton blended woven fabric because of higher jute percentage.

Table 6. Results of water take up % of 50% Jute & 50% Cotton blended woven fabric.

	Wet weight	Water take up %	Average
0.330 gm	0.901 gm	63.37%	
0.331 gm	0.902 gm	63.33%	63.39%
0.329 gm	0.901 gm	63.48%	

Table 7. Results of water take up % of 80% Jute & 20% Cotton blended woven fabric.

Dry weight	Wet weight	Water take up %	Average
0.529 gm	1.179 gm	55.13%	
0.531 gm	1.180 gm	55.00%	55.05%
0.530 gm	1.179 gm	55.04%	

6. Conclusion

Through this research it was analysis the effects of jute fibres percentage variation on Cotton Jute Blended woven fabric after dyeing process was characterized on weave design, yarn count, fabric density, cover factor, weight per unit area (g/m²), fabric strength, dyeing performances such as wash and rubbing fastness, drape ability, pilling resistance, reflectance and color strength. The study expresses that, the characteristics of blended yarn fabric can be used as fully cotton fabric which may reduce the dependability on importable cotton fiber and may reduce the dependability on 100% cotton yarn. By enhancing the value addition due to locally produced cheaper jute as a raw material, an opportunity to integrate the blended yarn into the production of jute cotton denim and other heavy fabrics too. If the principle of this research can be applied in textile production

purposes, it will be more beneficial to the textile sector.

References

- [1] Talukdar, M. K., Sriramulu, P. K., & Ajgaonkar, D. B. (1998). *Weaving: Machines, Mechanisms, Management*. Mahajan Publishers.
- [2] Shahid, M. A., Ahmed, F., & Mahabubuzzaman, A. K. M. (2012). Study on the Physical Properties of Jute-Cotton Blended Rotor Yarn. *SUST Journal of Science and Technology*, 20 (6), 84-88.
- [3] Salam, M. A., Farouqui, F. I., & Mondal, M. I. (2007). A Study on Sulphonated Jute-cotton Blended Yarn and Fabrics Jute-cotton Blended Yarn and Fabrics and their Characteristics. *Bangladesh Journal of Scientific and Industrial Research*, 42 (3), 281-286.
- [4] Charankar, S. P., Verma, V., & Gupta, M. (2007). Growing importance of cotton blends in apparel market. *Journal of the Textile Association*, 67 (5), 201-210.
- [5] ISO 13937-2: 2000, Textiles-Tear properties of fabrics-Part 2: Determination of tear force of trouser-shaped test specimens (Single tear method).
- [6] Yuen, C. W. M., S. K. A. Ku, P. S. R. Choi, and C. W. Kan. "Study of the factors influencing colour yield of an ink - jet printed cotton fabric." *Coloration technology* 120, no. 6 (2004): 320-325.
- [7] Prabu, H. Gurumallesh, and M. Sundrarajan*. "Effect of the bio - salt trisodium citrate in the dyeing of cotton." *Coloration technology* 118, no. 3 (2002): 131-134.
- [8] Phillips, Duncan, Geoff Bevan, John Lloyd, Robin Hall, and Jurgen Hoffmeister. "The colour fastness of dyed fabrics to activated oxygen bleach-containing detergents: an international interlaboratory trial." *Coloration Technology* 115, no. 3 (1999): 100-101.
- [9] ASTM D4966-98, Standard Test Method for Abrasion Resistance of Textile Fabrics (Martindale Abrasion Tester Method).

- [10] Cusick, G. E. "21-the measurement of fabric drape." *Journal of the Textile Institute* 59, no. 6 (1968): 253-260.
- [11] Sarkar, Ajoy K., and Corinne M. Seal. "Color strength and colorfastness of flax fabrics dyed with natural colorants." *Clothing and Textiles Research Journal* 21, no. 4 (2003): 162-166.
- [12] Solaiman, J. S. (2015). Comparative analysis of manual fading and laser fading process on denim fabric. *Science Discovery*, 3 (6), 44-49.
- [13] Karmaker, A. C., A. Hoffmann, and G. Hinrichsen. "Influence of water uptake on the mechanical properties of jute fiber-reinforced polypropylene." *Journal of Applied Polymer Science* 54, no. 12 (1994): 1803-1807.