

## Effect of scouring and laundering on functional properties of natural colour cotton fabric

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### ABSTRACT

Natural color cotton is eco-supportive as they possess colour naturally in varied shades viz., brown, green, cream and other tints and shades of these colours. It has unique comfort and handle property which provides soothing to the wearer. A medium brown natural colour cotton fibre was spun into 20s count yarn on open end spinning and the pure colour cotton fabric was developed on handloom and subjected to scouring. The scoured natural colour cotton fabric undergone with multiple wash cycles and assessed for mechanical, functional properties, colour fastness to sunlight and washing properties. Results revealed that, the scoured natural color cotton fabrics at washing and sunlight was found to be increase in color strength and decrease in reflectance than the pure NCC fabric. After laundering at multiple washes, the scoured natural colour cotton fabric exposed to direct sunlight, it was found that the colour strength was significantly reduced and fabric became lighter, duller and yellower. However, the scoured natural colour cotton fabric subjected to washing and shade dried exhibited significantly greater K/S, which indicates the sample became darker, brighter and greener than the sample expose to direct sunlight. The natural colour cotton fabrics has better mechanical, functional and fastness properties can be suitable for production of diversified cotton products ranging from children garments to trendy outfits. Hence, the promotion of natural colour cotton fabrics is a sustainable approach for green environment.

### Introduction

Cotton is one of the world's most socially vital and economically important agricultural crop and also the king of textile. Millions of people depend on cotton cultivation which suffices the basic necessity of mankind and is known for its diversity, enormous utility, applicability, economic viability and advantageous properties. Cotton with natural colour lint other than white is commercially referred as colour cotton and is known to mankind ever since the existence of agriculture and even

earlier to vedic period. Generally, due to smaller bolls and low ginning outturn of colour lint varieties are often low yielders with low productivity per unit area. The properties of colour cotton fibre are also poor in fibre length and strength values which is hardly machine spun. Other issues with these cottons include high whiteness percent, higher wax content, isolation distance requirements, the presence of only a few hues in consistency, and non-uniformity of fabric

colour throughout seasons and locales. In spite of these draw backs, the naturally colour cotton is gaining popularity in the world market due to its eco friendliness. Throughout the value chain of white cotton a large amount of chemicals, acid dyes, reactive dyes and basic dyes are required to make the white cotton as coloured. Added to this, to process the white cotton *i.e.*, fibre to fabric high amount of water is required and large quantity of effluents are generated with high level of BOD, COD, TS and TDS which further leads to environment pollution (Ramesh babu *et al.*, 2007). Usage of synthetic for textile colouration leads to many ecological problems and human health hazards which has forced to driven the attention towards eco-friendly textiles. The eco fashion business has provided an opportunity for creativity to revitalize age-old fibres and environmentally sustainable processes. Naturally coloured cottons are gaining importance in the recent years due to the integration of ecology, fashion and public's rising interest in environmental issues and environment-friendly production processes. These naturally coloured cottons reduce or eliminate the costly dyeing and bleaching procedures. Due to its eco-friendly aspect, coloured cottons have created a growing niche market in the developed countries (Parmar and Shanna (2002). Certainly, naturally colored cotton is eco-supportive as they can be finished devoid of chemical dyes. Though it possesses many favorable features and also associated with some limitations *viz.*, short staple length and coarser structure eventually producing coarse quality fabric which in turn exhibit poor aesthetic properties. Cotton, being a natural fibre, contains more natural impurities on its primary and secondary walls which in turn hinders the quality of the fabric. Hence, the scouring is an essential pretreatment for cotton which improves the strength, luster and absorbency. The dyed cotton fabrics with varied dye class (direct, reactive, basic, vat *etc.*) after multiple washing and expose to sunlight leads to colour fading due for photo oxidation. However, reaction to washing of natural colour cotton fabric is quite different from that of synthetic coloured cotton fabrics. On the contrary the natural colour cotton fabrics improve its wash fastness and colour intensify up to 10 washing and thereafter the colour intensity was reduced for sunlight. Many authors studied the chemistry and

reactive species involved in photo fading of dyed cotton fabric. The world is moving toward pollution-free organic textiles and products; the naturally colored cotton is going to be the next buzz word in the market, because of the production process of naturally coloured cotton skips the most polluting activity (dyeing) of the textile product manufacturing (Rathinamoorthy and Parthiban, (2019).

Hence the present study is designed with objectives to study the effect of scouring on mechanical and functional properties of natural colour cotton fabrics and to assess the colour strength of natural colour cotton fabric on washing and light fastness and its durability.

## Material and Methods

### Selection of raw material

Medium brown natural colour cotton fibre was procured from Agricultural Research Station Hebballi UAS Dharwad with following fibre properties (Table 1). The natural colour cotton fibre was spun into 20s count yarn on open end spinning and assessed for yarn evenness properties (Table 2). The yarn evenness properties of natural colour cotton yarn were measured in terms of thin places (- 50 %), thick places (+ 50 %), neps (+ 200) and total imperfections. The 20s pure colour cotton yarn was found the thin places (07), thick places (62), neps (27) and total imperfection rate of 96. Hairiness percentage of natural colour cotton yarn was found to be 4.10, unevenness percentage was 11.73 and count strength product of 1540.

**Table 1. Fibre qualities of natural colour cotton yarn (Brown Colour Hirsutum)**

| SN | Fibre Properties | Mean  | CV%  | Std. Dev. |
|----|------------------|-------|------|-----------|
| 1. | 2.5 % SL (mm)    | 20.39 | 2.80 | 0.57      |
| 2. | U.R. %           | 56.10 | 4.80 | 2.70      |
| 3. | Mic.10 (g/in)    | 3.78  | 0.80 | 0.03      |
| 4. | Tenacity(g/tex)  | 17.10 | 7.50 | 1.30      |
| 5. | Elongation %     | 8.11  | 9.90 | 0.80      |

### Development of natural colour cotton fabric

The pure natural colour cotton fabric was developed by interlacing 20s count yarn with plain weave on handloom with reed count of 44 and denting order of 2/dents (Plate 1).

**Table 2. Yarn evenness properties of natural colour cotton pure and blended yarn**

| SN | Parameters                   | NCC pure 20s count |
|----|------------------------------|--------------------|
| 1  | Thin Places (-50%)           | 07                 |
| 2  | Thick Places (+50)           | 62                 |
| 3  | Neps (+200)                  | 27                 |
| 4  | Total Imperfection           | 96                 |
| 5  | U %                          | 11.73              |
| 6. | Hairiness                    | 4.10               |
| 6  | CSP (Count Strength Product) | 1540               |

**Scouring of natural colour cotton fabric**

Scouring is the process wherein cotton fabric is essentially undergoing pretreatment operation with required amount of alkali. The primary purpose of scouring for cotton fabrics is to removes water insoluble materials such as oils, fats, and waxes from the material. Following recipe has used for scouring of natural colour cotton fabric (Table. 3 and plate 2 & 3).

**Table 3: Recipe for Scouring of natural colour cotton fabric**

|                                                            |                      |
|------------------------------------------------------------|----------------------|
| MLR (Material liquor ratio)                                | 1:20                 |
| Tween 80                                                   | 3 gpl                |
| NaOH (Sodium hydroxide)                                    | 3% owf               |
| Sequencing agent (EDTA-Ethylene diamine tetra acetic acid) | 1 gpl                |
| Temperature                                                | 40° to boiling point |
| Time                                                       | 8 folds              |

**Laundering of natural colour cotton fabric**

Fabric durability is one of the most important factors that determine the shelf life of the textile substrates for attaining better performance. The scoured natural colour cotton fabric was subjected for multiple washes (20 washes) using liquid detergent (3gpl) at the MLR of 1:30 and assessed for colour fastness properties.

**Assessment of mechanical and functional properties**

The pure and scoured natural colour cotton fabrics were assessed for mechanical properties *viz.*, cloth count (Ne), cloth weight (GSM), cloth thickness

(mm), cloth crease recovery (degree) and cloth stiffness (cm) using standard test procedures. The functional properties *viz.*, cloth tensile strength, elongation, air permeability and wettability were assessed for pure and scoured natural colour cotton fabrics using standard test procedures (Tables 4 & 5).

**Table 4: Standards for assessment of mechanical properties of Natural coloured cotton fabrics**

| Mechanical properties | Standard test procedure |
|-----------------------|-------------------------|
| Cloth density         | BS 2862:1957            |
| Cloth thickness       | ASTM D177-1975          |
| GSM                   | IS 1964: 2001           |
| Cloth crease recovery | IS 4681:1968            |
| Bending length        | BS 3356-1961            |

**Table 5: Standards for assessment of functional properties of Natural coloured cotton fabrics**

| Functional properties                 | Standard test procedure |
|---------------------------------------|-------------------------|
| Cloth Tensile strength and Elongation | IS 1969-Part1-2009      |
| Spray test                            | AATCC 22-2017           |
| Air permeability test                 | IS 11056 1984           |

**Colour strength (K/S)**

Colour strength (K/S) values of the natural colour cotton fabrics were measured by using spectrophotometer. Five readings recorded for each and an average value was calculated. Where, K is the absorption coefficient and S is the scattering coefficient.

**Assessment of colour fastness properties of natural colour cotton fabric**

The scoured colour cotton fabric was subjected to multiple washing and assessed for fastness property by using two methods *viz.*, Colour fastness to sunlight and Colour fastness to washing.

**Colour fastness to sunlight**

The natural color cotton fabrics of 1× 6 cm were wound closely on a black card sheet and was mounted in an exposure rack. The rack was placed at 45° for eight days, and it was exposed from 9 a.m. to 3 p.m. (6 hours every day). The samples were evaluated for colour change after 48 hours of



Plate 1: Natural colour cotton trendy outfits.



Plate 2: Scouring of natural colour cotton fabrics



Plate 3: Scouring of natural colour cotton fabrics

exposure with the help of spectrophotometer (380-780 nm) compared with blue wool standard.

#### **Colour fastness to washing**

The natural colour cotton materials were stitched along all four sides between two adjacent pieces of cloth, one side silk and the other cotton. The composite specimen was agitated in the rotary shaker for 30 minutes with a preheated (402 °C) soap solution (5 g/l) of MLR 1:30. (42rpm). After laundering, the colour fastness of samples was determined using a spectrophotometer and compared with gray scale.

### **Results and Discussion**

#### **Effect of scouring on mechanical properties of natural colour cotton fabrics**

Cloth count of the woven textile material is the number of ends and picks per unit area which is influenced by the yarn count and compactness of the weave. From the table 6, it is observed that, the warp density of pure and scoured natural colour cotton fabrics was relatively greater than the weft and the cloth density was found to be significantly greater between both the fabrics. Among the fabrics, the cloth count was found to be greater in scoured natural colour cotton fabric in both warp (56) and weft (35) direction compared to control fabric (warp: 54 & weft: 30) respectively. It may be because of removal of impurities during the scouring process and maximum consolidation of threads takes place resulted into formation of compact structure which leads to increased cloth count. The results are on par with the results of Prabakaran (2003) who reported that, after number of wet processing, treatments the cotton fabric was prone to shrink considerably resulting in high thread density. The total cloth weight of scoured natural colour cotton fabric was found to be significantly greater (130) than pure natural colour cotton fabric (126). The cloth thickness was found to be significantly higher in scoured natural colour cotton fabric (0.50) than pure natural colour cotton (0.47) fabrics. It may be due to the consolidation of threads/unit area resulting into greater cloth thickness which yields to higher cloth weight.

Further, the cloth stiffness was found to be significantly greater in pure natural colour cotton fabric both in warp (2.36) and weft direction (2.23) than scoured natural colour cotton fabric (warp:

2.00 & weft: 1.90) respectively. This may be due to the removal of impurities present in the woven fabric structure that makes the fabric softer and more pliable. The results are on par with the results of Shrikant *et al.* (2005) who revealed that, fabrics become less stiffer after the scouring possibly due to removal of fats and waxes. Moreover, the cloth crease recovery angle was found to be significantly greater in weft of both pure and scoured natural colour cotton fabric than warp direction. Scoured natural colour cotton fabric was found to be greater crease recovery angle (warp: 75 & weft: 81) as compared to pure natural colour cotton fabric (warp: 72 & weft: 77) respectively, which indicates the scoured fabrics become more softer and pliable. Dimensional stability of fabric calculated in terms of percentage, it refers to change of fabric size when they are washed or relaxed. After scouring the natural colour cotton fabric was increased the dimensional stability in both warp (76.16%) and weft (91.00%) direction as compared to pure natural colour cotton fabric (warp: 70.96%, weft: 88.00%) respectively.

#### **Effect of scouring on functional properties of natural colour cotton fabrics**

The tensile strength is a stress applied on a fabric which is measured as force per unit area. It is observed from the table 7 that, the scoured natural colour cotton fabrics exhibited greater tensile strength in both warp (135.9) and weft way (45.8) as compared to pure NCC fabric (warp: 123.2, weft:40.3) respectively. Similarly, the elongation percentage of scoured fabric was found to be greater in both warp (2.4) and weft (2.5) direction than pure NCC fabric. In general, fabric strength and elongation properties were significantly increased after scouring this may be due to consolidation of thread density. The strength of fibers is attributed to the rigidity of the cellulosic chains, the highly febrile and crystalline structure, and the extensive intermolecular and intramolecular hydrogen-bonding (Hsieh, 2007). Further, the alkali has improved the molecular arrangement of the fibre resulting in to greater per cent of crystalline regions in the fibre thus enhancing the strength of the yarn and fabric on scouring (Gandhad and Naik, 1999; Magadi, 2002).

Wettability refers to a fabric's ability to absorb liquid and is determined by the balance of surface

energy at the interface of air, liquid, and solid components. The wetting of cotton depends upon the properties of the fibre surface and the liquid which is going to wet it. The surface energy of a textile structure in the uppermost layers is important in the wetting and adhesion of liquids. The fabric surface energy is largely dependent upon

the structure of the fibre, as well as on the yarn, fabric, capillary forces, cover factor, area density, level of projected fibres, and surface roughness (Uddin and Lomas (2010)). The samples wettability was evaluated using ratings, where the scoured NCC fabrics rated as zero which indicates completely wetting of whole upper and lower

**Table 6: Effect of scouring on mechanical properties of natural colour cotton fabrics.**

| SN | Mechanical Properties              | Pure NCC fabric | Scoured NCC fabric | t value |
|----|------------------------------------|-----------------|--------------------|---------|
| 1. | Cloth count (Numerical Expression) |                 |                    |         |
|    | Warp                               | 54              | 56                 | 1.22    |
|    | Weft                               | 30              | 35                 | 3.87    |
| 2. | Cloth weight (GSM)                 | 126             | 130                | 4.89    |
| 3. | Cloth thickness (mm)               | 0.47            | 0.50               | 3.67    |
| 4. | Cloth bending (cm)                 |                 |                    |         |
|    | Warp                               | 2.36            | 2.00               | 8.52    |
|    | Weft                               | 2.23            | 1.90               | 6.45    |
| 5. | Cloth crease recovery (angle)      |                 |                    |         |
|    | Warp                               | 75.00           | 72.00              | 3.67    |
|    | Weft                               | 81.00           | 77.00              | 4.89    |
| 6. | Dimensional stability (%)          |                 |                    |         |
|    | Warp                               | 70.96           | 76.16              | 3.40    |
|    | Weft                               | 88.00           | 91.00              | 3.67    |

**Table 7: Effect of scouring on functional properties of natural colour cotton fabrics**

| SN                                                | Mechanical Properties                     | Pure NCC fabric | Scoured NCC fabric | t value        |
|---------------------------------------------------|-------------------------------------------|-----------------|--------------------|----------------|
| 1.                                                | Cloth Tensile strength (N)                |                 |                    |                |
|                                                   | Warp                                      | 123.4           | 135.9              | 5.49           |
|                                                   | Weft                                      | 40.3            | 45.8               | 5.30           |
| 2.                                                | Cloth elongation (%)                      |                 |                    |                |
|                                                   | Warp                                      | 1.7             | 2.4                | 2.06           |
|                                                   | Weft                                      | 1.8             | 2.5                | 3.36           |
| 3.                                                | Wettability (Rating)                      | 70              | 0                  | 12.24          |
|                                                   | Air permeability (c/sec/cm <sup>2</sup> ) | 40.56           | 38.25              | 7.15           |
| <b>Wettability</b>                                |                                           |                 |                    | <b>Ratings</b> |
| Complete wetting of whole upper and lower surface |                                           |                 |                    | 0              |
| Complete wetting of whole upper surface           |                                           |                 |                    | 50             |
| Partial wetting of whole upper surface            |                                           |                 |                    | 70             |

surface. However, untreated NCC fabric was rated as 70 which depicts partial wetting of whole upper surface of the fabric. This may be due to scouring process which removes the cuticle or wax present in the outer layer of the cotton fibers, which enables cotton to absorb moisture more quickly as stated by

Gohl and Vilensky (1987). The amount of air that passes through a specific area of a fabric is measured by its air permeability. This characteristic has a significant impact on the thermal comfort attributes of materials. It is generally accepted that the air permeability of a fabric depends on its air



porosity, which in turn influences its openness. It was found that, the air permeability was negatively influenced on scouring process of natural colour cotton fabrics which ascribed to increasing the fabric density, weight and thickness after successive wet processes. These results are in line with the Shrikant *et al.* (2005) who stated that, threads/cm were found to be higher in scoured fabric than grey fabric resulted into higher cloth cover-factor of scoured fabric and lesser air permeability. Further, grey fabrics were found to have high air permeability and contrary, lower values of the air permeability were associated with scoured woven fabrics as stated by Najwa (2019).

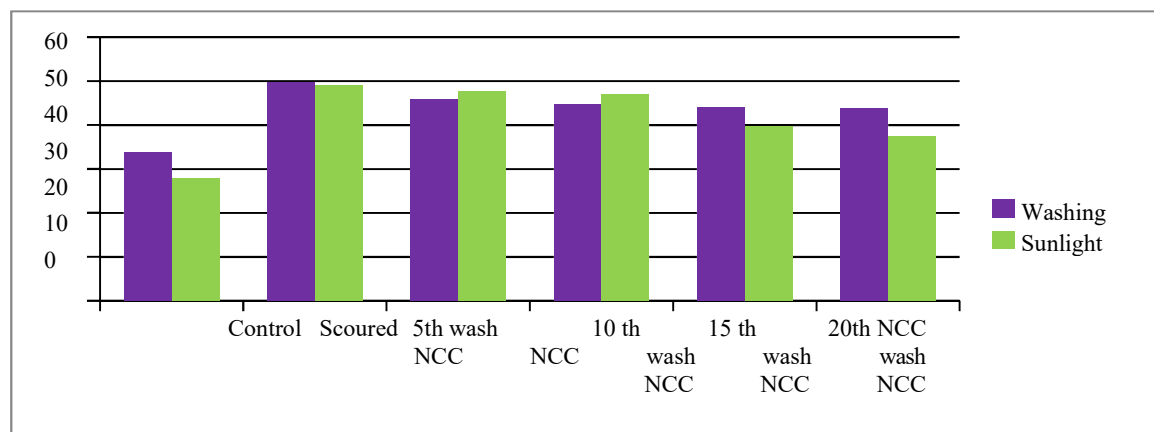
#### Effect of laundering on colour strength of natural colour cotton fabrics

It was observed from the table 8 and Fig. 1 that, the

colour strength of natural colour cotton fabric was increased after scouring treatment *i.e.*, 49.770 as compared to control fabric (33.820). These results are on par with the results of Tsaliki *et al.* (2016) who stated that, the influenced of enzymatic treatment on brown cotton was found to be noticed that, the colour fastness properties were improved. However, the effect of washes on scoured natural colour cotton fabric was showed that there was increased in colour strength after every wash compared to control sample. This may be due to the fact that, the natural colour cotton present in the form of pigment inside the lumen of fibre tends to break the core and comes out on the surface during 2nd and subsequent washes, resulting in the enhancement of colour in terms of K/S value thus causing the shade intensification (Parmar and Sharma, (2002).

**Table 8: Effect of laundering on colour strength of natural colour cotton fabrics.**

| SN                  | Fabrics                                | Colour strength (K/S) |          |       |       |
|---------------------|----------------------------------------|-----------------------|----------|-------|-------|
|                     |                                        | Washing               | Sunlight |       |       |
| 1.                  | Control natural colour cotton fabric   | 33.820                | 27.190   |       |       |
| 2.                  | Scoured natural colour cotton fabric   | 49.770                | 48.952   |       |       |
| 3.                  | 5th wash natural colour cotton fabric  | 45.856                | 47.604   |       |       |
| 4.                  | 10th wash natural colour cotton fabric | 44.768                | 46.996   |       |       |
| 5.                  | 15th wash natural colour cotton fabric | 43.964                | 39.592   |       |       |
| 6                   | 20th wash natural colour cotton fabric | 43.832                | 37.420   |       |       |
| Source of variation |                                        | S.Em. $\pm$           | CD5%     | CD1%  | CV    |
| Factor A            |                                        | 365.497               | 1.554    | 2.076 | 4.060 |
| Factor B            |                                        | 84.633                | 0.897    | 1.199 |       |
| Treatments (AxB)    |                                        | 122.361               | 2.198    | 2.936 |       |



**Figure 1. Effect of laundering on colour strength of natural colour cotton fabrics.**

Effect of sunlight on colour strength of control and scoured natural colour cotton fabrics describes that, as the number of washes increases and subsequently expose to direct sunlight leads to decrease in colour strength of scoured natural coloured cotton fabric. This may be because of photo oxidation/fading due to oxygen liberation. Among the samples treated with washing and sunlight, the colour strength was found to be greater in washed and shade dried samples than the samples exposed to direct sunlight even after multiple washes. This indicates that, the natural colour cotton fabric were susceptible to photo fading by direct sunlight which may breaks the colour pigment in the fibre structure. Further, after multiple washes, the scoured natural colour cotton fabrics exhibited darker colour shades than the control sample. It indicated that the sample became more darker, greener and bluer than the control sample. However, after multiple washes with shade dry intensify the colour of the fabrics upto 10 washes, after that the colour intensity was reduced. ANOVA explains that, there was a greater significant difference was found between the colour strength of all the NCC samples for washing as well as sunlight samples.

### Effect of laundering on colour reflectance of natural colour cotton fabrics

Colour reflectance is directly associated with colour strength (K/S) of the sample. As the colour strength values increases, there was reduction in reflectance values which indicates samples became more darker and visa versa. Table 9 and figure 2 explains the effect of laundering on colour reflectance of natural colour cotton fabrics. Among the samples, pure natural colour cotton fabric was more lighter than the scoured natural colour cotton fabrics. However effect of laundering on colour reflectance of the samples explains that, as the number of washes increases the samples became slightly lighter and duller as supported by reflectance values of 5th, 10th, 15th and 20th washes (8.248, 8.498, 8.326, 8.672) respectively. Further, the samples subjected to sunlight after multiple washes narrates, there was a slight increase of reflectance value which indicates that the samples became more lighter and results are supported by colour strength values (table.8). Interaction between the factors, the reflectance was significantly increased in all the natural colour cotton fabrics subjected to scouring and washing compared to sunlight samples.

**Table 9: Effect of laundering on colour reflectance of natural colour cotton fabrics.**

| SN                  | Fabrics                                | Colour reflectance |          |       |
|---------------------|----------------------------------------|--------------------|----------|-------|
|                     |                                        | Washing            | Sunlight |       |
| 1                   | Control natural colour cotton fabric   | 10.270             | 11.972   |       |
| 2.                  | Scoured natural colour cotton fabric   | 7.670              | 9.510    |       |
| 3.                  | 5th wash natural colour cotton fabric  | 8.248              | 9.396    |       |
| 4.                  | 10th wash natural colour cotton fabric | 8.498              | 7.940    |       |
| 5.                  | 15th wash natural colour cotton fabric | 8.326              | 7.546    |       |
| 6                   | 20th wash natural colour cotton fabric | 8.672              | 7.368    |       |
| Source of variation |                                        | SEm ±              | CD5%     | CD1%  |
| Factor A            |                                        | 14.441             | 0.301    | 0.402 |
| Factor B            |                                        | 1.748              | 0.174    | 0.232 |
| Treatments (AxB)    |                                        | 4.565              | 0.426    | 0.569 |
|                     |                                        |                    |          | CV    |
|                     |                                        |                    |          | 3.804 |

### Effect of laundering on colour difference of natural colour cotton fabrics

The colour difference of natural colour cotton fabrics subjected to wash and light fastness showed in table 10 and figure 3. The colour difference of natural colour cotton fabrics subjected to wash fastness property exhibited increased colour difference of scoured sample (1.502) compared to control sample (0.880) and washed samples.

Further in washed samples, increased colour difference was found in 10th wash sample (1.032) followed by 20th wash (0.336), 5th wash (0.204) and 15th wash samples (0.120) respectively. However, in sunlight samples significantly increased in colour difference was noticed in 20th wash sample (1.476) compared to control sample (1.272). Among the washed samples, the more colour difference was found in 20th wash sample



followed by 5th wash (0.664), 15th wash (0.586) and 10th wash sample (0.356) respectively. From the ANOVA, observed that the colour difference was increased significantly in sunlight control sample compared to washing natural colour cotton fabric. The sunlight scoured sample has significantly decreased the colour difference compared to wash fastness of scoured sample.

Among the washed sample, the significantly increased colour difference was found in 5th, 15th and 20th wash samples of sunlight compared to wash fastness samples. Moreover, the colour difference was found to be increased in the 10th wash sample compared to sunlight 10th wash sample.

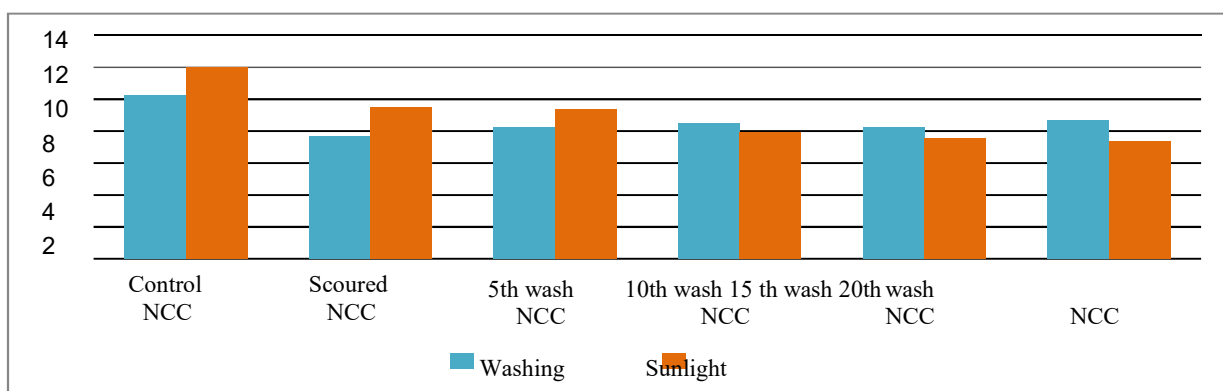


Figure 2: Effect of laundering on Colour reflectance of Natural colour cotton fabrics.

Table 10: Effect of laundering on colour difference (dE) of natural colour cotton fabrics.

| SN                  | Fabrics                                | Colour difference |          |       |        |
|---------------------|----------------------------------------|-------------------|----------|-------|--------|
|                     |                                        | Washing           | Sunlight |       |        |
| 1                   | Control natural colour cotton fabric   | 0.880             | 1.272    |       |        |
| 2.                  | Scoured natural colour cotton fabric   | 1.502             | 0.872    |       |        |
| 3.                  | 5th wash natural colour cotton fabric  | 0.204             | 0.664    |       |        |
| 4.                  | 10th wash natural colour cotton fabric | 1.032             | 0.356    |       |        |
| 5.                  | 15th wash natural colour cotton fabric | 0.120             | 0.586    |       |        |
| 6                   | 20th wash natural colour cotton fabric | 0.336             | 1.476    |       |        |
| Source of variation |                                        | SEM $\pm$         | CD5%     | CD1%  | CV     |
| Factor A            |                                        | 1.157             | 0.235    | 0.313 | 33.588 |
| Factor B            |                                        | 0.553             | 0.135    | 0.181 |        |
| Treatments (AxB)    |                                        | 1.257             | 0.332    | 0.181 |        |

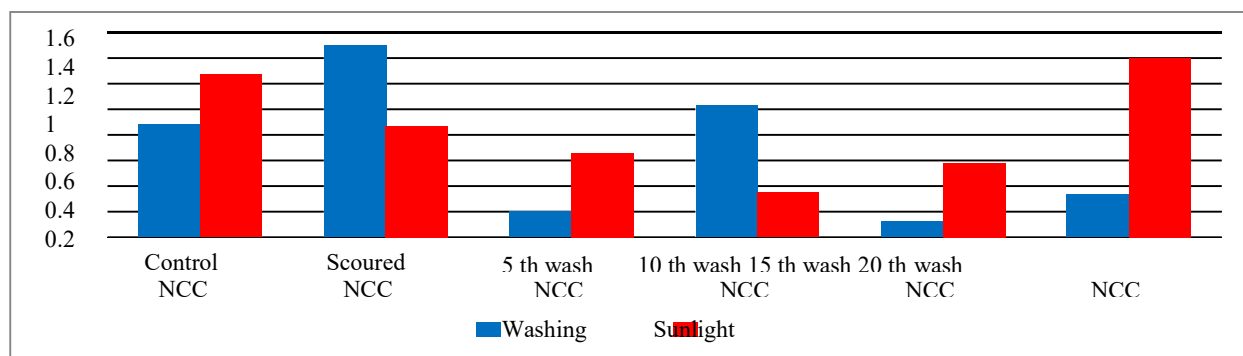


Figure 3: Effect of laundering on colour difference of natural colour cotton fabric.

### Effect of laundering on colour fastness to washing and sunlight of natural colour cotton fabric

Table 11 discloses the effect of washing on colour fastness with respect to change in colour and colour on stain material. Scoured natural colour cotton fabric subjected to different washing cycles *i.e.*, 5th, 10th, 15th and 20th wash and assessed for colourfastness to washing. It was interesting to observed that all the natural colour cotton fabrics possessed good wash fastness even after 20th wash. There was no much change observed in all the samples subjected to washing cycles *i.e.*, 5 to 15th indicating the samples are good fastness to washing. This may be due to the fact that the natural colour present in the form of pigment inside

the lumen of fibre tends to break the core and comes out on the surface during 2nd wash, resulting in the enhancement of colour in terms of K/S value, thus causing the shade intensification (Parmar and Shanna (2002). Further the effect of colour fastness to sunlight on wash durability of scoured natural colour cotton fabric. Irrespective of multiple washes (0, 5, 10, 15 and 20) the treated samples exhibited moderate to excellent fastness properties (4/5-7). Among the washed samples, upto 10th washed samples showed very good to excellent wash fastness to sunlight property. However, after 15th and 20th washes the fastness ratings was found to be good to moderate which indicates that there was colour fading occurred after multiple washes and subsequent expose to sunlight.

**Table 11: Effect of laundering on natural colour cotton fabric on colour fastness to washing and sunlight.**

| SN | Fabrics                                       | Colour fastness property |                      |
|----|-----------------------------------------------|--------------------------|----------------------|
|    |                                               | Washing (gray scale)     | Sunlight (blue wool) |
| 1. | Scoured natural colour cotton fabric (o wash) | 5                        | 7                    |
| 2. | 5th wash fabric                               | 5                        | 7                    |
| 3. | 10th wash fabric                              | 5                        | 6                    |
| 4. | 15th wash fabric                              | 4/5                      | 5/6                  |
| 5. | 20th wash fabric                              | 4                        | 4/5                  |

### Conclusion

The scoured natural colour cotton fabric found to be denser, thicker, heavier, soft and pliable than the control sample. It has good tensile, elongation properties, better wettability and air permeability. The scoured natural colour cotton fabrics exhibited greater colour strength and lesser reflectance values with slight colour difference. Colour fastness properties of natural colour cotton fabric exhibited good to excellent (4/5-5) for sunlight with multiple washes. The natural colour cotton fabrics has better mechanical, functional and fastness properties can be suitable for production of diversified cotton products ranging from children garments to trendy outfits. Hence, the promotion of natural colour cotton fabrics is a sustainable approach for green environment. Similarly eco-consciousness is

increasing world over and green minded consumers are prepared to pay more for textile eco-friendly products and one among them is natural colour cotton. Natural colour cotton fabrics are eco-friendly with unique handle and comfort property.

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### Conflict of interest

The authors declare that they have no conflict of interest.

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