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# EFFECT OF MERCERIZATION UNDER TENSION ON THE DRAPABILITY AND STRENGTH OF COTTON KHADI FABRIC

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## ABSTRACT

Present study was aimed at assessing the effect of mercerization under tension on physical properties (drapability and tensile strength) of gray cotton khadi fabric. Different parameters of mercerization treatment such as conc. of sodium hydroxide palates and time duration of the treatment were optimized. Two methods of the treatment were given (slack mercerization and mercerization under tension) at 40°C with different concentrations (5%, 15% and 25%) for different time periods (10min, 20min and 30min). The treated cotton khadi fabric was evaluated in terms of tensile strength and drapability of cotton khadi fabric. Mercerization under tension gave the best results with 25% concentration of NaOH for 30min at 40°C followed by the fabric, with different time (10min and 20min) duration of the treatment. The results showed that as the time and concentrations were increased, the tensile strength was also increased of mercerization under tension as compare to the controlled and slack mercerization samples. Some properties were decreased after mercerization treatment for example %drape co-efficient was decreased and drape area also decreased means andanother mode of subjective expression of drapability i.e. higher the no. of nodes betters the drape quality. Thus the Drapability was increased.

**KEYWORDS:** Cotton Khadi Fabric, Drapability, Mercerization under Tension, Slack Mercerization and Tensile Strength

## INTRODUCTION

Mercerization is one of the most important finishing processes of value addition to cotton material and it is a chemical treatment which improves the physical and mechanical properties of cotton fabric. This method is discovered in 1844 and patented in 1850 by the English calico printer John Mercer and hence fourth this process has been called mercerization, studied by Vatsala (2003) and Kumar (2015). It is also used in the finishing of linen. When cotton fibers are immersed in the alkali solution (sodium hydroxide or liquid ammonia) at a specified concentration for a specified time, and then rinsed with stretching, according to Kim et al. (2006). Mercerization causes the flat twisted, ribbon like cotton fiber to swell in to a round shape and contact in the length. The fiber becomes much lustrous than the original fiber, and its strength is increased by as much as twenty percent, According to B. Corbman (1983). When mercerization is carried out on tension fiber, the shape of coiled cotton fiber is change: it straights out and the characteristics, lumen completely disappears. (Shenai, 1995)

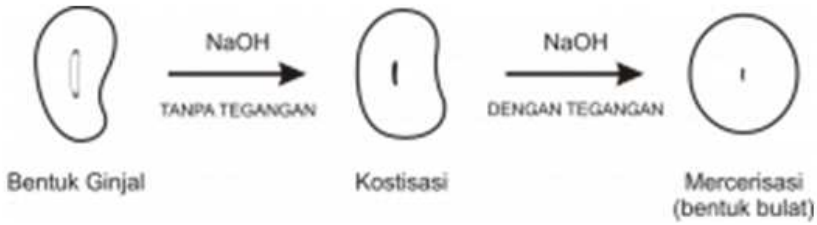



**Figure 1: Morphological Changes during Mercerization (Shanai, 1995)**

Jordanov et al. (2010) studied on, the strong alkaline solution causes the fiber to swell up and become gelatinous and transparent in its structure. It gives greater absorptive properties. It facilitates uniform dyeing in addition to improving dimensional stability, smoothness, tensile strength, and a high degree of luster, depending on the method used. Changes in microstructure, morphology, and conformation of the cellulose chains also occur during mercerization. Shenai, reported in 1995 that Mercerization can be carried out either in a slack or under tension condition. In case of slack mercerization the length or width of the cotton fabric decreases its one fourth. In case of under tension mercerization process, it will not be decrease and it will also increase the luster and strength.

The first true Indian designer was Mahatma Gandhi ji, who urged to the people of India to wear khadi garments. Khadi is an Indian handspun and hand-woven cloth and an eco-friendly textile. The raw materials may be cotton, silk, or wool, which are spun into threads on a spinning wheel called a charkha. The cotton *khadi* is woven in such a way that the interlacing of threads provide maximum exchange of air to the body, thus giving a cooling effect, making *khadi* an ideal summer wear and it has various plus points over other fabric that is unique in texture, looks brilliant and produces in various weaves studied by Mishra (2012). It prevents skin rashes and imparts very elegant and sober look. It is comfortable fabric but it has some drawbacks such as it is hand woven and hand spun fabric so it has less luster and strength. During washing, fabric will shrink and snag. In this research mercerizing treatment will be given to improve properties of cotton khadi fabric. Present study was planned to find out the effect of mercerization on physical the properties of gray cotton khadi fabric. The objective of this study was: To study the effect of various concentrations, time and temperature of treatment of mercerization on the physical properties of cotton khadi fabric.

## EXPERIMENTAL

### Material and Methods

The grey cotton khadi fabric samples were taken for the study of(55 × 61) yarn count, weighing 1.43 gm (GSM), and purchased from Khadi Bhandar of BanasthaliVidyapeeth, Niwai, (Tonk) Rajasthan. To remove the sized from the gray cotton khadi fabric, a desizing treatment was realized and also to remove the waxes and oils attached to grey (natural) fabrics that interfere with proper dyeingand scouring treatment was also given. Bleaching was done on all the samples at 90$^{o}$C for 30 min in a solution contains 4ml/l hydrogen peroxide (35%), 2g/l sodium carbonate and 2g/l stabilizer. All the experiments were carried out in the Department of Clothing &Textiles' laboratory, Banasthali University, Niwai (Tonk), Rajasthan.

### Slack Mercerization Treatment on Cotton Khadi Fabric

Treatment was done after Desizing, scouring and bleaching to the grey cotton khadi fabric. The process was done using two methods i.e. slack mercerization and under tension mercerization. The treatment was done using three

concentration of Sodium Hydroxide solution i.e. 5% 15% and 25% for different time duration i.e. 10min, 20min and 30min at 40$^{o}$ C. After this process the samples were washed with clean water and then dry to all the samples.

The full treatments of Mercerization under tension had done in stretched (under tension) condition then the samples dry also in under tension condition.

**Mercerization under Tension**

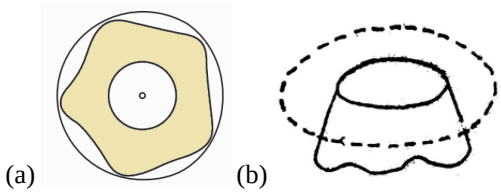
**Process-**For the research work, wooden rollers **(2"×20")** were developed with the help of carpenter. Tocontinue the treatment process, Firstly a rectangle piece of the cotton khadi fabric **(18"×70")** was taken and ends of the samples were string with the rollers then prepare a NaOH solution of treatment in a tray. The above ready sample was put in to the solution in the relaxed condition for a control time period. After socking, the samples were taken out from the solution of caustic soda then stretched the samples. After stretching the samples till the mark of marker, which was equal to the sample size, the samples were rinsed in stretched condition and dried in same condition. The samples were again washed under tension and stretched till drying.

**Determination of the Physical Properties**

Physical properties (tensile strength and drapability) were determined before and after the treatment to the cotton khadi fabric using both mercerization methods i.e. slack Mercerization and under Tension Mercerization with different concentration (5%, 15% and 25%) and time duration (10min, 20min and 30min) of the treatment at 40$^{o}$C.

**Percent drape coefficient**

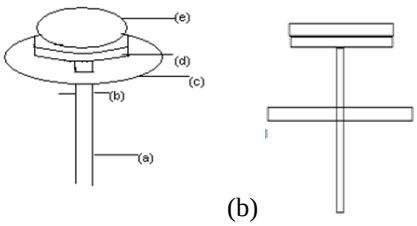
To determining percent drape coefficient of fabric, a drape meter was constructed on the bases of IS: 8357-1977 method as directed by Chu et al. (1950) and Bahera (2008). Circular fabric specimens of 30cm diameter were cut from each fabric using a hard paper template. Circular papers of the same diameter were placed on hard board disc and used for making shadows of the draped specimens.



(a) (b)

**Figure 2: (a) Circular Specimen Drapes (b). Projected Outline of Draped Specimen**

A 28 cm long center rod (a) was taken and a clamp was fixed 8cm below the top edge of the rod. A 30cm diameter hard board disc(c) was placed on the clamp. Another two discs of 15cm in diameter were cut from hardboard. One disc (d) was fixed on the top edge of the rod. Another was used as a lid (e) on the instrument.




(a) (b)

**Figure 3: (a) Front View of Drapometer over Circular Support (b) Side View of Drapometer**

Hard disc (c) was raised closed at the top disc (d). A specimens was placed in such a way that center of the specimen coincides with center rod. The second disc (e) was placed over the fabric so as to fold the specimen in position. The hardboard disc (c) was slowly taken down on the clamp thus allowing the specimen to drape under its own weight. With the help of narrow light, a shadow of the draped specimen was obtained on the circular paper placed on the hard board disc (c). The outline of the shadow was drawn on the paper. Shadow area was cut out with scissors and weighted on analytical balance. Weight per unit area of paper used was also determined. The percent drape coefficient of fabric was calculated from following formula.

Percent drape coefficient = $= \frac{A-\pi R22}{\pi R12 - \pi R22} \times 100$

R1 = 15 cm

$R_2$ = 7.5 cm

A = Area of shadow in square centimeter

'A' was calculated from the following formula-

$$\mathbf{A = \frac{w}{W}}$$

Where w = mass per unit area of paper

W = mass of the draped pattern

Representative calculation of % drape coefficient-

$$\mathbf{A = \frac{w}{W}}$$

W = mass per unit area of paper =.0024 gm per square cm

W = mass of the draped pattern= 1.06gm

Therefore $A= \frac{1.06}{.0024} = 441.66$

$\pi R12 = \frac{22}{7} \times 15 \times 15 = 707.14$

$\pi R12 = \frac{22}{7} \times 7.5 \times 7.5 = 176.76$

% drape coefficient = $\frac{A-\pi R_2^2}{\pi R_1^2 - \pi R_2^2} \times 100$

$$= \frac{441.66-176.78}{707.14-176.78} \times 100$$

**Tensile Strength and Elongation**

It is defined on the bases of ISO 6892-1 test method as the ability of the material to resist capture by external tension. Booth defines in 1986 to tensile load or stress in warp and weft direction. “Fabric strength is strength is measurement of the resistance of the fabric to a tensile load in either warp or weft direction. Fabric specimens of 12”×3”were cut. Longer dimension was kept parallel to the series of the yarn to be tested tensile strength tester was used which is based on constant rate of traverse. Sample were put in the clamp in such a way that upper and lower clamp were holding the same yarn. Machine was switched on lower jaw started to move at a constant rate. When the sample broke, machine stopped. Breaking load and elongation was read from dial. Five specimens warp wise and weft wise were tested. Mean value were calculated for warp and weft separately.

## RESULT AND DISSCUSSIONS

After the pretreatments the grey cotton khadi fabric was mercerized with sodium hydroxide pallets and determined the effect of mercerization on the grey cotton khadi fabric then compares the physical properties of cotton khadi fabric between slack mercerization and under tension mercerization.

**Determination of the Physical Properties of Cotton Khadi Fabric Treated by Sodium Hydroxide Palates**

**Drapability**

Drape is an important property of textile material which allows fabric to orient itself into graceful folds or pleats as a result of force of gravity.

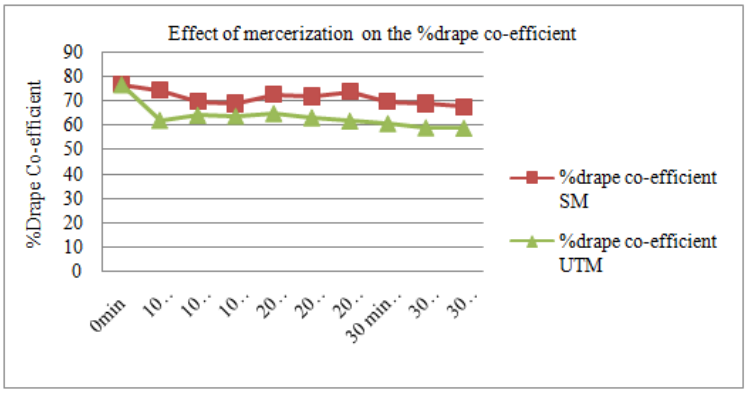



**Figure 4: Effect of Mercerization on Drapability of Cotton Khadi Fabric (SM- Slack Mercerization, UTM-Under Tension Mercerization)**

The style of the garment and its drape determine the amount of drape that is needed and accordingly the fabric is selected. The objective evaluation of the cloth drapability is expressed in terms of percent drape co-efficient; however the drape quality of the same fabric may be evaluated subjectively and expressed in terms of nodes. The figure 4 illustrates the drape quality of the controlled and starched treated test samples. Drape co-efficient of controlled sample of cotton khadi fabric was 76.67% which decreased considerably on the application of NaOH. On increasing the concentration and time, the percent drape coefficient was decreased. In some cases of slack mercerization, the cotton khadi fabric gave similar

results like control sample. But when time and concentration was increased, the %drape co-efficient was reduced as compare to the control sample.

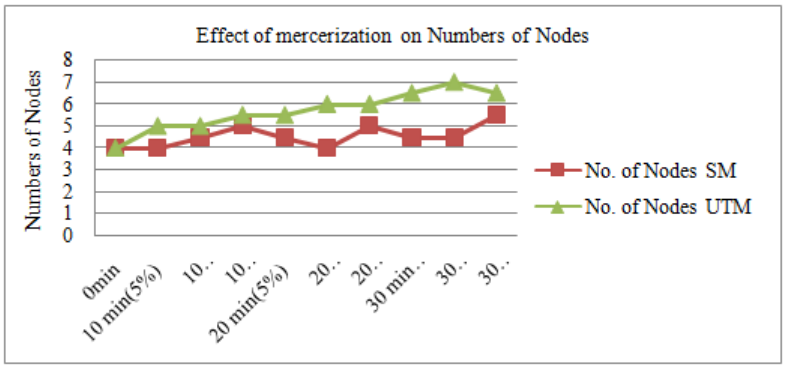



**Figure 5: Effect of Mercerization on Percent Drape Co-Efficient of Cotton Khadi Fabric**

From the figure (5), it was depicted that in case of mercerization under tension, the time and concentration was increased, the % drape co-efficient was reduced as compare to the slack mercerization. Thus it is noticed from the said figure that the %drape co-efficient was decreased in case of mercerization under tension as compare to the slack mercerization. The results were also supported with no. of nodes, another mode of subjective expression of drapability i.e. higher the no. of nodes betters the drape quality. As it had been shown that the no. of nodes were increased after the treatment of mercerization. When increased time and concentration than the no of nodes was increased in case of mercerization under tension as compare to the controlled sample.

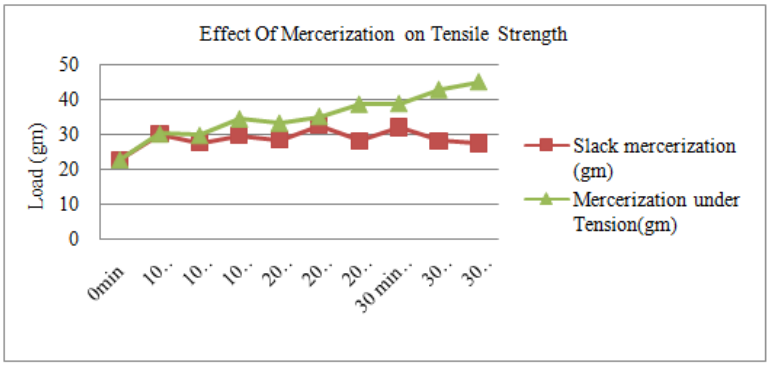



**Figure 6: Effect of Mercerization on Tensile Strength of Cotton Khadi Fabric**

**Tensile Strength**

Akhbari et al. (2012) studied that the strength of the mercerized yarn is highly affected by the warm rinsing temperature and caustic soda bath concentration, while the effect of the cold rinsing temperature is observed only for higher qualities of cotton fibers and yarns while the figure (6) contains tensile strength of the un mercerized and mercerized cotton khadi material, was measured in two cases, slack mercerization and mercerization under tension. Here the figure (6) shows the effect of various parameters i.e. times and concentrations of NaOH on tensile strength of cotton khadi fabric. Tensile strength of the cotton khadi fabric can be assessed by applying the load. In the figure 6, the tensile strength of the gray cotton khadi fabric was less than the mercerized samples, because which was increased considerably on the application of increasing concentration of NaOH. When time and concentration was increased, the tensile strength was

increased in the mercerized

sample as compare to the control sample. Hence it was observed, that tensile strength of the cotton khadi fabric was increased in all cases of the treatment of mercerization under tension as compare to the slack mercerization.

## CONCLUSIONS

Commercially available cotton khadi fabric was treated with caustic soda solution at different concentration of caustic soda 5%, 15%, 25% and varying in time 10min, 20min, 30min were applied. Present study was under taken to modify those characteristics of khadi fabrics which are relevant to the garment making to get desired drape in to the garments. It can be concluded from the results that as the time and concentration was increased, the tensile strength was also increased in case of mercerization under tension as compare to the controlled and slack mercerization samples. And some properties were decreased after mercerization treatment for example %drape co-efficient was also decreased but no. of nodes was increased and draping area also decreased. Thus the Drapability was increased and the cotton khadi fabric got good drapability and the fabric became drapableand more comfortable. Hence it was concluded that the draped aria was found less, and Drapability was increased of the mercerization under tension as compare to the slack mercerization treatment.

## REFERENCES

1. Akhbari, M., et al., Optimization of parameters influencing mercerization using the RSM method in order to increase the tensile strength of mercerized yarn. *Fibres & Textiles in Eastern Europe*, vol. 94 (5), pp. 30–35.2012.
2. Booth, J. E., Principles of Textile Testing: An Introduction to Physical Methods of Testing Textile Fibres, Yarns and Fabrics. Butterworths Publications. New Delhi, India: 1986. Pp. 432-435
3. BIS. Indian Standard Method for assessment of fabric drape. IS: 8357 – 1977. 2004.
4. Behera, B.K. et al., Measurement and modeling of drape using digital image processing. *Indian Journal of Fiber & Textile Research.* Vol. 33, pp. 230-238, 2008.
5. Chu CC, et al., Mechanics of Elastic Performance of Textile Materials: Part V: A Study of the Factors Affecting the Drape of Fabrics -The Development of a Drape Meter. Textile Research Journal; 20(8): 539-48. 1950.
6. Corbman B.P., Textiles: Fiber to Fabric. McGraw-Hill publication, *McGraw-Hill International Editions*.1983.
7. Jordanov, I. et al., Mechanical and structural properties of mercerized cotton yarns, bio-scoured with pectinases. *ResearchGate*.59 (10):439-446. 2010.
8. Kim, S. et al., Mercerization in Degassed Sodium Hydroxide Solution. *Fibers and Polymers.* Vol.7, No.2, 186-190. 2006.
9. Kumar, P., Caustic mercerization and liquid ammonia mercerization on cotton fabric. 2015. https://www.linkedin.com/pulse/caustic-mercerization-liquid-ammonia-cotton-fabric. Retrived on 25th February 2016

10. Mishra, N.,"Naturally Coloured Cotton Designer's Apparel: An Emerging Trend in Khadi World."Ph.d. Thesis, Dept. of Textile and Apparel Designing. The University of Agricultural Sciences, Dharwad, India.2012.
11. Shenai, V.A., Technology of Bleaching and Mercerization. Sevak Publications, Bombay. III$^{rd}$ Edison: 493-500. 1995.
12. Vatsala, R., Textbook of Textiles and Clothing. Published by Indian Council of Agricultural Research, PP. 164-165.2003.