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# Investigation on the Physical and Dimensional Properties of Single Jersey Fabrics made from Cotton Sheath - Elastomeric Core Spun

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## Abstract

*In this study, the physical and dimensional properties of single jersey fabrics made from cotton / elastomeric core spun yarn were investigated. The main purpose of this paper was to investigate the suitability of cotton - spandex core spun yarn for circular knitting as an alternative for bare spandex feeding and the effect of stitch length variables on knitted fabric geometric quality attributes such as wale density, course density, stitch density and areal density under different states of relaxation. The results clearly indicate that the resulting yarn is highly suitable for circular knitting and change in stitch length values does not have any significant impact on wale density values. At the same time, the remaining geometric properties of the samples were found to be inversely proportional to the stitch length values uniformly at all the states of relaxation. Along with this, the ability of the samples to reach the dimensional equilibrium state after repeated cycles of washing and drying was also studied. It is evident from the results that all the three samples produced with ascending stitch length orders attained a perfect state of dimensional stability before five cycles of washing and drying, and also the sample knitted with the smallest stitch length value reached its equilibrium state in a quick time.*

**Key words:** single jersey fabrics, elastomeric yarns, core spun yarns, cotton, spandex yarns.

**Abbreviations:** CSSJ – Core Spun Single Jersey, DRS I – Dry Relaxed State after Knitting, DRS II – Dry Relaxed State after Heat Setting, WRS – Wet Relaxed State, FRS – Fully Relaxed State after five repeated cycles of washing and tumble drying, l – Stitch Length in cm.

## Introduction

The revolution in the fashion knitwear industry has become inevitable due to the frequent changes in fashion trends, leading to the production of knitted apparels using different yarn types, fabric types, designs and style variations. These elements play a very significant role in fashion trends, especially in segments such as casual wear and sportswear [1 - 3]. Plain knitting takes up about 90% of all knitted fabric consumption. Hence the dimensional stability of plain knitted fabrics has been one of the most widely investigated areas for many years. Many previous studies [4 - 9] have reported the effects of physical parameters such as yarn linear density, yarn twist, loop length, the tightness factor, finishing treatment and degree of washing on the dimensional properties of knitted fabrics. Schulze [10] investigated the dimensional properties of single jersey, lacoste, and fleecy fabrics knitted with cotton/spandex yarns and reported that the weight and loop densities of cotton/spandex fabrics were

higher than cotton fabrics; also the extension, both widthwise and lengthwise, increased as the relaxation progressed. In this research work, 19.68 tex cotton-elastomeric core spun yarn was spun and knitted on a multi-track circular knitting machine with dia. 18" and gauge 24 using three different stitch length variables such as 0.27 cm, 0.30 cm and 0.33 cm. After that, the geometric and dimensional properties were studied for all the samples developed at different states of relaxation to find their suitability for mass production. The effect of the stitch length and tightness factor on the geometric and dimensional properties of the samples developed were analysed and reported. A suitable stitch length range is recommended for the given count of yarn for commercial fabric production.

## Materials and methods

The methodology adopted for this work is as given below:

Production of 19.68 tex cotton air cover – elastomeric core combed hosiery yarn  
↓  
Development of jersey samples with different stitch length variables (0.27 cm, 0.30 cm and 0.33 cm)  
↓  
Dry relaxation of fabric samples in standard atmospheric conditions and study of geometric properties  
↓  
Heat setting to stabilise the elastomeric part of fabric samples and study the changes in geometric properties after

one more dry relaxation in standard atmospheric conditions  
↓  
Wet relaxation of fabric samples in standard atmospheric conditions and study the changes in geometric properties of fabric samples  
↓  
Repeated cycle of washing and drying to obtain a fully relaxed state of fabric samples and to study the dimensional stability  
↓  
Study of geometric properties after repeated cycles of washing and drying at a fully relaxed state

## Results and discussion

### Effect of stitch length on wale density

It is observed from the results shown in *Figure 1.a* that the wale density values are found to be low for all the samples at their DRS I. After that, these values gradually increased during every relaxation state and reached their peak uniformly for all the samples at their FRS. There is a marginal difference noticed in the values of wale density for different stitch length values at all the relaxation states. However, the difference between them is negligible. The small but steady increase in wale density values from one relaxation state to another for any given stitch length may be because of the continuous widthwise contraction of the fabric samples to a certain extent.

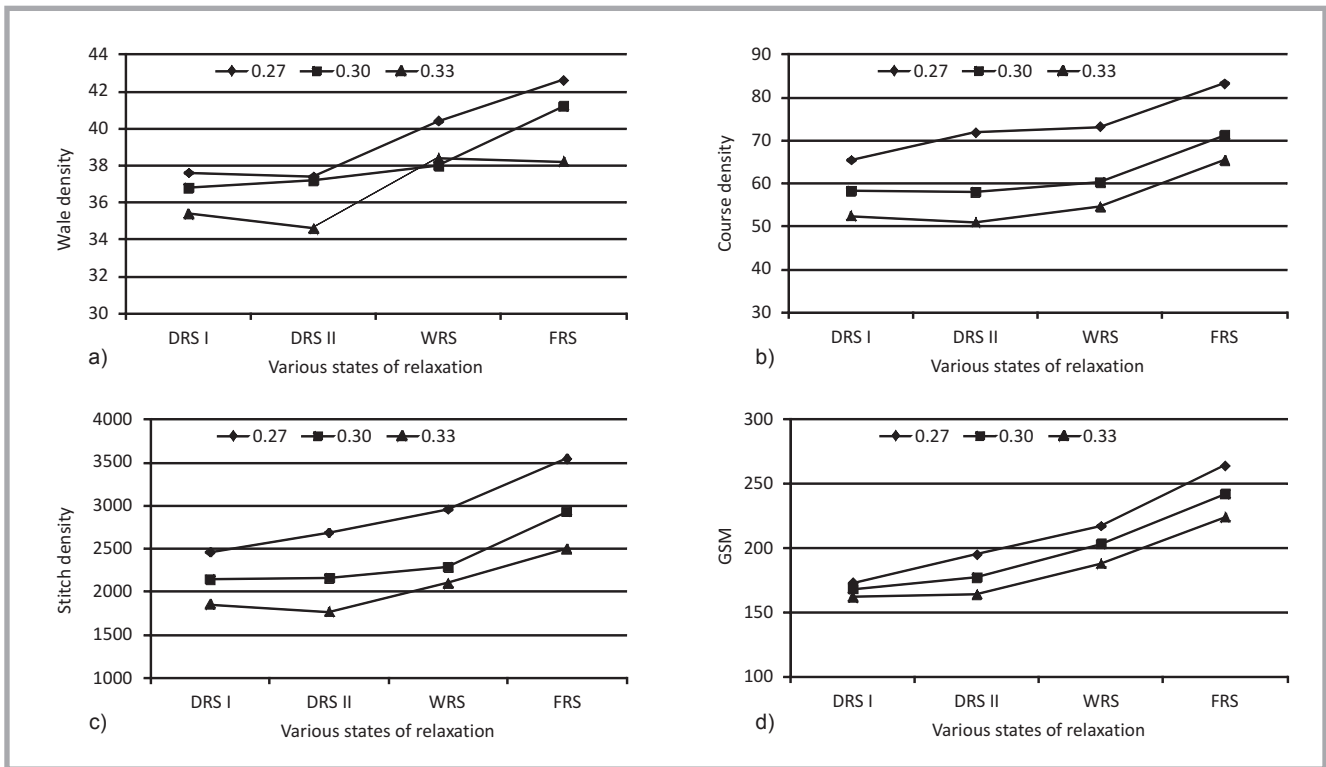


Figure 1. Relationship between stitch length and: a) wale density, b) course density, c) stitch density and d) GSM.

### Effect of stitch length on course density

From the results depicted in *Figure 1.b* it is apparent that the course density is inversely proportional to the stitch length. In every state of relaxation the sample knitted with a smaller stitch length showed a higher course density value and vice-versa. The course density values of larger and medium stitch length samples had a very minimal decrease between their DRS I and DRS II, and after that a gradual increase in the subsequent wet relaxation state, reaching their maximum at the fully relaxed state. However, the sample knitted with a smaller stitch length showed a continual increase in all the relaxation states.

### Effect of stitch length on stitch density

It is evident from the results shown in *Figure 1.c* that there is an overall increase in the stitch density after every relaxation state for all the stitch length values given. It is also visible that there is a gradual increase in stitch density from a higher to smaller stitch length under various states of relaxation.

### Effect of stitch length on GSM

From the results shown in *Figure 1.d* it is clear that the samples knitted with larger and medium stitch length values have a minimal increase in their areal

density between their DRS I and DRS II, but there is a drastic increase afterwards. However, the sample with a smaller stitch length shows an appreciable increase after every state of relaxation. In the former case the length wise contraction may be low till DRS II and there may be a sudden increase in contraction during WRS and FRS. In the latter case there may be an appreciable lengthwise contraction after every relaxation state. The uniform and gradual increment in areal density values at all the relaxation states from a larger to smaller stitch length once again proves that areal density is a geometric prop-

erty inversely proportional to the stitch length.

### Dimensional stability of the samples after repeated cycles of washing and tumble drying

The consolidated results of repeated cycles of washing and drying and subsequent dimensional changes are shown in *Figure 2* for the core spun single jersey samples developed.

All the three samples attained their widthwise dimensionally stable state immediately after their first wash and

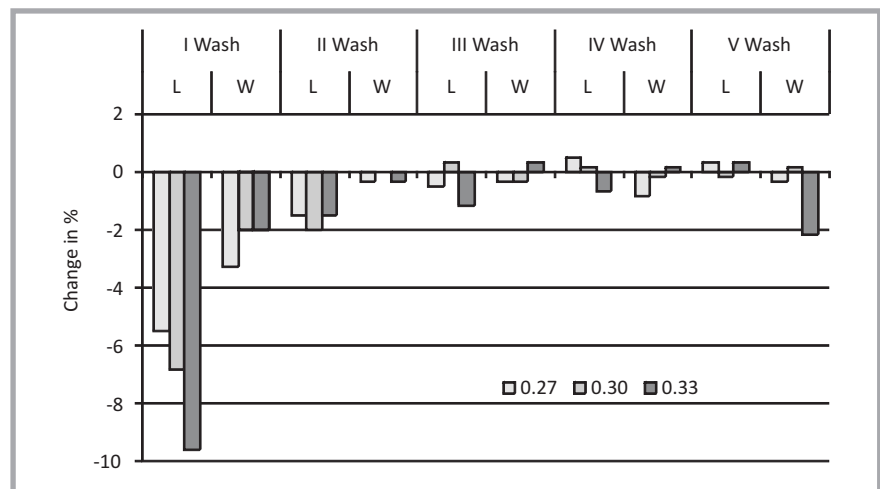


Figure 2. Dimensional stability of the CSSJ samples after repeated cycles of washing and tumble drying.

lengthwise dimensionally stable state only after their second wash. From the third wash onwards negligible change in the dimensions was uniformly noticed both length and widthwise in all the samples. The results clearly showed that all three samples have the potential to reach and retain their dimensional equilibrium state very rapidly.

## ■ Conclusions

1. Cotton sheath and Elastomeric Core Spun yarn has prerequisite qualities for knitting such as adequate strength, elongation, uniformity and low hairiness. Thus the knitting of all the samples was found to be easier on a circular knitting machine.
2. The property wale density is not influenced by the change in stitch length values, which is evident from the insignificant difference in the wale density values of the samples knitted with different stitch length values. The reason for the trivial increase or decrease found in the values of wale density within and between the samples during the specific relaxation state may be because of the respective widthwise shrinkage or growth of the samples.
3. Other geometric properties such as course density, stitch density, area density and the tightness factor were found to be inversely proportional to the stitch length value at all the relaxation states. These properties reached

their peak uniformly in the case of the fabric developed with a small stitch length and vice-versa at all the relaxation states.

4. The fabric samples knitted with the stitch length range selected showed excellent dimensional stability in both the length and width directions, which is clear from the results of repeated cycles of washing and drying. From the results of dimensional stability, it is apparent that all the fabric samples knitted are able to reach their minimum energy level, and hence a state of equilibrium, in a rapid manner. The fact that widthwise stability is ensured immediately after the first wash and lengthwise stability after the second wash is a key point to note.
5. Finally the conclusion can be drawn that all the stitch length values within the range of 0.27 cm to 0.33 cm are suitable for mass scale knitting according to the various commercial requirements using 19.68 tex cotton-elastomeric core spun yarn.



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