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Dimensional Properties of Single Jersey Knitted Fabrics Made from New and Regenerated Cellulosic Fibers

J. C. Sakthivel, Assistant Professor
N. Anbumani, Associate Professor
Department of Textile Technology
PSG College of Technology
Peelamedu, Coimbatore, India

ABSTRACT

. In this study, dimensional properties of viscose, modal and lyocell single jersey knitted fabrics with three level of loop lengths were studied under dry, wet and fully relaxation conditions. An attempt has been made to investigate the influence of different fiber types such as viscose, modal and lyocell fibers on the dimensional properties of single jersey knitted fabric. The three fibers were selected with similar fineness and fiber length as 1.5 d X 38 mm. The 14.8 tex staple spun yarn made with viscose, modal and lyocell fibers has been knitted with three level of loop lengths and the knitted fabrics is subjected to dry, wet and fully relaxed states. The effect of fiber type, loop length and relaxation treatments on the dimensional properties of single jersey knitted fabrics were statistically analyzed using an analysis of variance. The course and wale spacing values of lyocell fabrics found lower than that of viscose and modal knitted fabrics. Lyocell fabrics shows, higher areal density with decreasing loop length. It is also found that, ks value of the lyocell fabrics is increases proportionally with increase in the value of tightness factor, compare than viscose and modal fabrics. The fabrics made from lyocell shows maximum bursting strength and lower spirality as compared with viscose and modal fabrics, due to the structural characteristics of lyocell fibers. Single jersey knitted fabrics made with lyocell fibers shows better dimension properties compare than viscose and modal fabrics. .

Keywords: Circular knitting machine, Dimensional properties, Lyocell, Modal, Spun viscose yarn, Weft knitted fabric

1. INTRODUCTION

In recent years there has been a very fast growth in the knitting section of the textile industry. A demand for weft knitted garments has increased many folds over the years in the domestic and export markets. Dimensional stability of knitted fabrics has been one of the most discussed areas in the textile industry as well as in research fields [1]. Because of the dimensional instability of knitted loop construction, single jersey knitted fabrics suffers from various forms of dimensional distortion [2]. Parmer [3] reported that efforts are being made to make a knitted fabric more comfortable by changing the fibers, yarn parameters (twist, bulk, count and finish), knitting parameters (courses per inch, wales per inch, loop length and fabric weight) and post knitting finishes (enzyme and chemical). The Single Jersey knitted fabric properties especially the dimensional and physical properties are mainly influenced by the constituent fibers, yarn properties, knitting machine variables, processing and finishing treatments.

Munden [4] and Doyle [5] have extensively investigated the dimensional properties of wool and cotton knitted fabrics and predicted that the length of the yarn in the knitted loop plays a major role in determining the dimensions of a knitted fabrics. Munden [4] carried out a study of fabric relaxation and fabric geometry with wool yarns. He firstly defined two relaxed states, if a fabric after knitting has been allowed to lie freely for a sufficient length of time; it eventually reaches a stable state which is called the dry relaxed states. In the dry relaxed state, the natural configuration of yarn is almost straight so that when it is un rowed, the yarn takes up an approximately straight form. The state of equilibrium reached by a fabric after static relaxation in water and subsequent drying is called the wet relaxed state. In the wet relaxed state, yarn is set so that the natural configuration of yarn is not straight but is set into a form approximating the loop shape in the fabric. This implies that the forces which are necessary to keep the yarn in loop shape in the dry relaxed state, are reduced in the wet relaxed state. Knapton [6] has also studied the dimensional properties of wool knitted fabrics and concluded the importance of K values on the dimensional properties. Sharma [7] has studied the dimensional properties of acrylic knitted fabrics and concluded that the fabrics made from different yarns and counts, the courses per inch and wales per inch vary inversely with the length of yarn knitted into the stitch.

The dimensional and physical properties of weft knitted fabrics, particularly made with cotton, wool and acrylic has been studied by many investigators [8-10]. However, not much has been reported for weft knits made out of viscose, modal and lyocell fibers. There has been a growing demand for absorbent fibers with the need hinging on comfort and fashion. All regenerated cellulosic fibers have the same chemical composition, yet they differ in density, molecular mass, degree of polymerization, super molecular arrangement, and above all, their degree of crystallinity and orientation. The main differences in structure, and consequently in fiber properties, originate from variations in production processes. Regenerated synthetic fibers, especially modal and lyocell fibers production has helped in the development of new apparels and created tremendous possibilities to achieve improved dimensional, physical, mechanical and aesthetic properties of apparel fabrics [11-14].

In order to study the influence of fiber type, loop length and relaxation treatments on dimensional properties of knitted fabric, three different fibers such as viscose, modal and lyocell with similar fineness and fiber lengths were used. This present study discusses the influence of viscose, modal and lyocell fibers, loop length and relaxation treatments on the dimensional properties of single jersey knitted fabrics.

2. MATERIALS AND METHODS

The objective was to compare the dimensional and physical properties of the single jersey knitted fabrics made from viscose, modal and lyocell fibers. Viscose, modal and lyocell fibers with1.5 d fineness and 38 mm staple length was chosen for this study. The viscose, modal and lyocell yarns were spun on a miniature ring frame with 14.8 tex and 866.14 twist per meter. Table 1 shows the properties of viscose, modal and lyocell spun yarns. The fabrics were knitted from 14.8 tex (40 Ne) viscose, modal and lyocell yarns on a circular knitting machine of 24 gauge and 18 inches diameter.1356 needles and 72 number of feeders were used on a circular knitting machine. The fabrics were knitted on a clockwise rotating circular knitting machine. Three different loop lengths (0.35, 0.40 and 0.45 cm) were chosen to produce a single jersey knitted fabric samples from a viscose, modal and lyocell spun yarns and all the fabrics are subjected to dry, wet and fully relaxation treatments. The effect of loop length and relaxation treatments on dimensional and physical properties of the single jersey knitted fabrics were analyzed by two way ANOVA statistical tool at 95% confidence level.. The methodology followed for this work is shown below:

2.1 METHODOLOGY

Viscose (V), Modal (M) and Lyocell (L) fibers (1.5 d X 38 mm)

↓

Production of 100 % viscose, modal and lyocell ring spun yarns (14.8 tex X 866.14 twist per meter)

↓

Production of viscose, modal and lyocell single jersey knitted fabrics (Stitch length 0. 35 (1), 0.40 (2) & 0.45 (3) cm)

↓

Sample code (V1,V2,V3,M1,M2,M3,L1,L2,L3)

↓

Dry, wet and fully relaxation treatments

↓

Testing of dimensional and physical properties of the single jersey knitted fabrics

Table 1. Properties of 100% Viscose, Modal and Lyocell stable spun yarns

S. No	Yarn Properties	Viscose	Modal	Lyocell
1	Nominal Count, tex	14.8	14.8	14.8
2	Actual Count, tex	14.91	15.10	14.98
3	Nominal Yarn twist, twist per meter	866.14	866.14	866.14
4	Actual Yarn twist, twist per meter	878.73	849.60	861.02
5	Tenacity ,g/tex	13.33	18.93	19.46
6	Elongation,%	18	12	15

The following relaxation treatments were applied to viscose, modal and lyocell single jersey knitted fabrics after knitting.

2.2 DRY RELAXATION

After being knitting, the knitted fabrics had been taken from the machine and were laid flat freely to relax for about 24 hr at standard atmospheric conditions. The dry relaxed dimensional properties were measured at this stage.

2.3 WET RELAXATION

Wet relaxation was carried out in water at room temperature, fabric was allowed to lay for 8 hours, hydro extracted and dried naturally for a day. At this stage, the dimensional properties of the sample were measured.

2.4 FULL RELAXATION

The fully relaxed condition were obtained by subjecting the samples into gentle agitation at 80° C for 2 hours, tumbles dried at 80° C for 2 hours in a domestic top loading washing machine, and finally dried in the standard atmosphere for 24 hours. At this stage, the dimensional properties of the sample were measured.

3. RESULTS AND DISCUSSION

The dimensional properties of single jersey weft knitted fabrics made from 14.8 tex viscose, modal and lyocell spun yarns with three different loop lengths has been investigated under three different conditions such as dry, wet and fully relaxation. The process of dry, wet and fully relaxation for a knitted fabric involves change in the internal force situation for the structure so as to bring about an equilibrium state of minimal internal energy.

3.1 EFFECT OF COURSE AND WALE SPACING

Course and wale spacing are directly related to stitch densities which represent the changes in loop shape during relaxation treatments. Figure 1. shows the relationship between course spacing and loop length of viscose, modal and lyocell single jersey fabrics and Figure 2. shows the relationship between wale spacing and loop length of viscose, modal and lyocell single jersey fabrics. The values of course and wale spacing are plotted against the loop length for viscose, modal and lyocell single jersey fabrics. It is noticed that for the different stage of relaxation, course and wale spacing and the loop length are linearly related. It is also noticed that, course spacing variations of viscose, modal and lyocell structures gradually decreased under dry and wet relaxation treatments and comparatively increases in fully relaxed states. The lower course and wales spacing values were reported with lyocell fabrics than viscose and modal fabrics. A possible reason is that, due to lower wet elongation of lyocell fibers in the lyocell yarns, loop shape comparatively stable state in the lyocell knit structures compare than modal and lyocell structures. Effect of loop length on course and wale spacing of the viscose, modal and lyocell single jersey knitted fabrics have significant at 95 % confidence level.

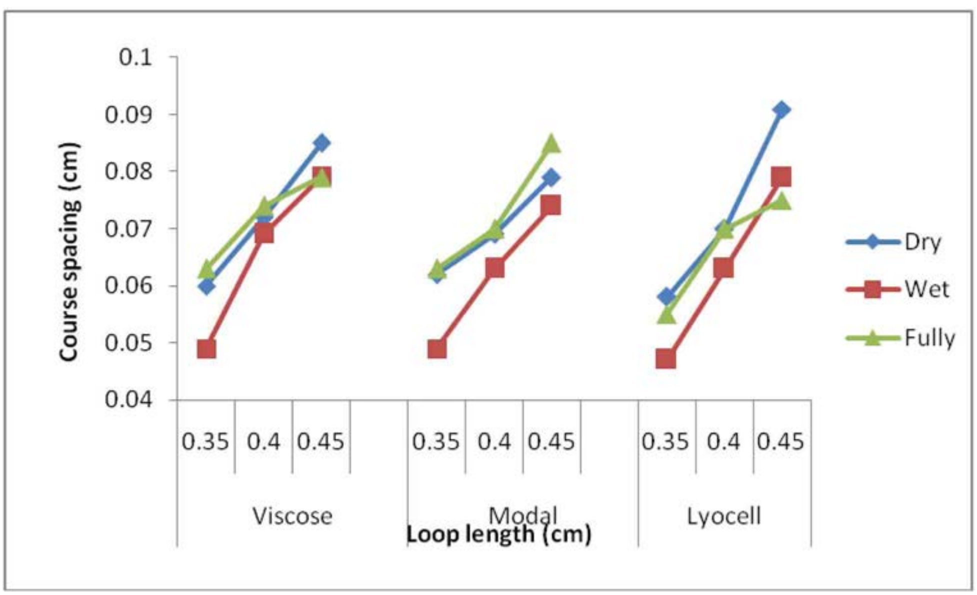

Figure 1. Relationship between course spacing and loop length of viscose, modal and lyocell single jersey knitted fabrics

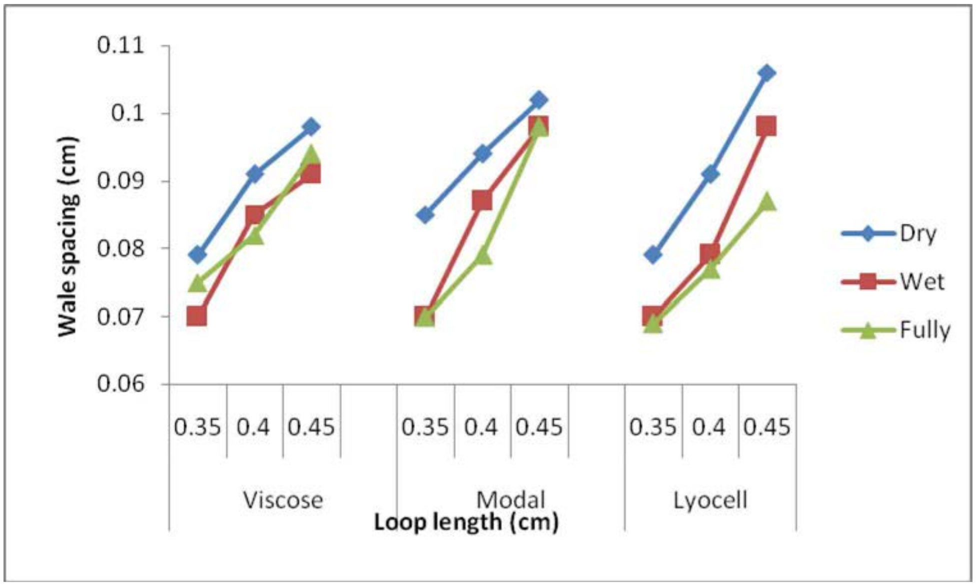

Figure 2. Relationship between wale spacing and loop length of viscose, modal and lyocell single jersey knitted fabrics

3.2 EFFECT OF STITCH DENSITY

The use of stitch density or number of loops per unit area of fabric is preferred, since it is less affected by distortion. It is observed that for the viscose, modal and lyocell structures, the stitch density varies linearly with the reciprocal of loop length. Figure 3. Shows the relationship between stitch density and reciprocal of loop length for viscose, modal and lyocell single jersey fabrics. Course and wale spacing are directly related to the stitch densities of the knitted fabrics. The lower values of course and wale spacing in lyocell fabrics is responsible for higher stitch densities in the fabrics compare than viscose and modal fabrics. Stitch density is directly responsible for determining the dimensional stability of the knitted fabrics. The influence of loop length on stitch density of the viscose, modal and lyocell single jersey knitted fabrics have significant at 95 % confidence level.

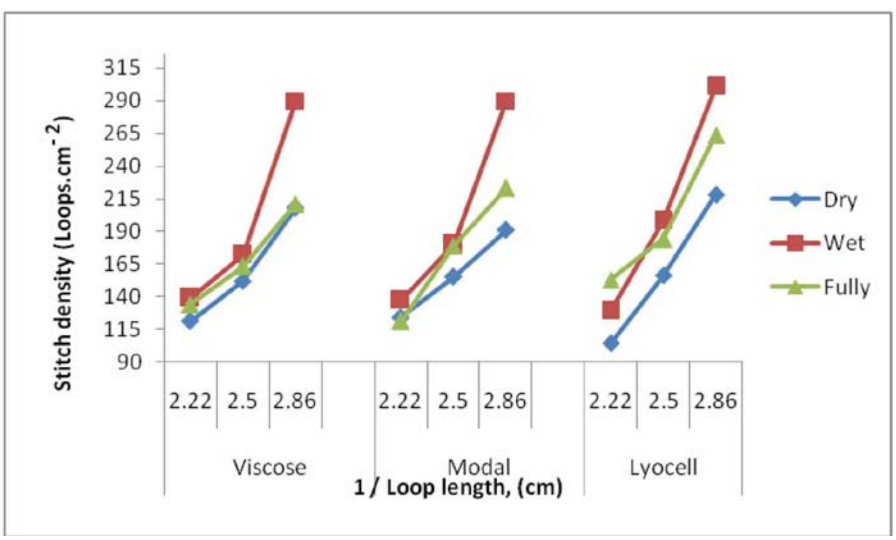

Figure 3. Relationship between stitch density and reciprocal of loop length of viscose, modal and lyocell single jersey knitted fabrics

3.3 EFFECT OF FABRIC WEIGHT PER UNIT AREA

Figure 4. Shows the relationship between fabric weight and reciprocal of loop length for viscose, modal and lyocell single jersey fabrics. Fabric weight is plotted against the reciprocal of loop length for the viscose, modal and lyocell fabrics under dry, wet and fully relaxed states. It is observed that areal density of the viscose, modal and lyocell fabrics is linearly related to the loop length. However, lyocell fabrics shows, higher areal density with decreasing loop length compare than viscose and modal fabrics. A possible reason is that, due to more stitches per unit area compare than viscose and modal fabrics. The influence of loop length and relaxation states on the weight of the viscose, modal and lyocell single jersey knitted fabrics have found to be significant.

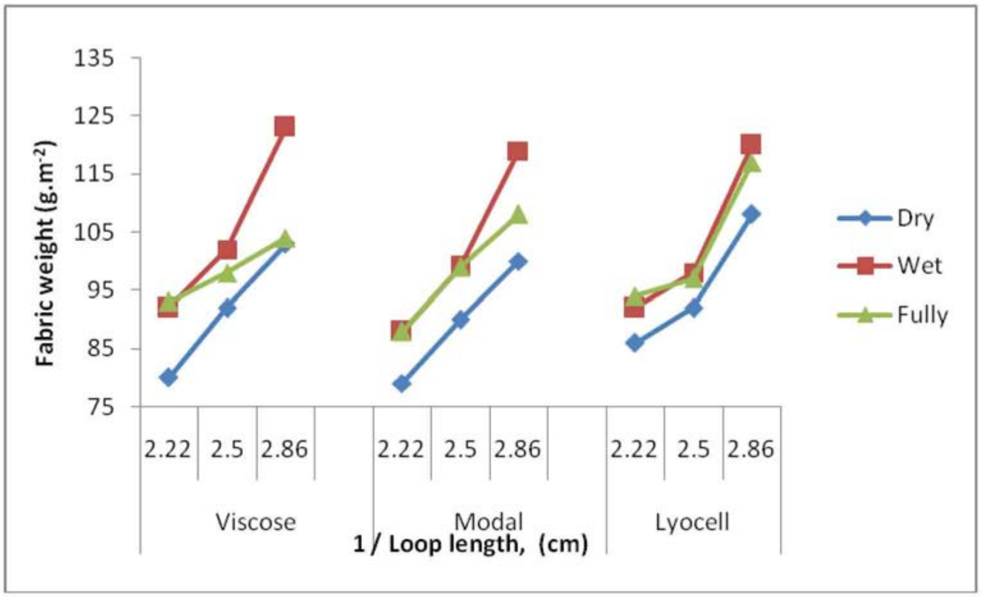

Figure 4. Relationship between fabric weight and reciprocal of loop length of viscose, modal and lyocell single jersey knitted fabrics

3.4 EFFECT OF RELAXATION TREATMENTS ON Kc, Kw AND Ks

Kc, Kw and Ks are the geometrical constants of the single jersey knitted fabrics and depend on the actual configuration of the knitted loop. The length and width dimensions of the viscose, modal and lyocell knitted fabrics are dependent on the tightness factor. Figure 5. Shows the relationship between Kc and tightness factor for viscose, modal and lyocell single jersey fabrics. The values of Kc, Kw and Ks are plotted against tightness factor of viscose, modal and lyocell knitted fabrics. Figure 6. Shows the relationship between Kw and tightness factor for viscose, modal and lyocell single jersey fabrics. It is observed that the difference in the values of kc, kw of all the fabric is noticeable but small. It is also found that, ks value of the lyocell fabrics is increases proportionally with increase in the value of tightness factor, compare than viscose and modal fabrics as shown in figure 7. The effect of tightness factor and relaxation state on dimensional constants such as Kc, Kw and Ks were also studied for three different fabrics. It was observed that, the tightness factor has no influence on dimensional constants of the fabrics. But, Kc and Ks were influenced by relaxation treatments.

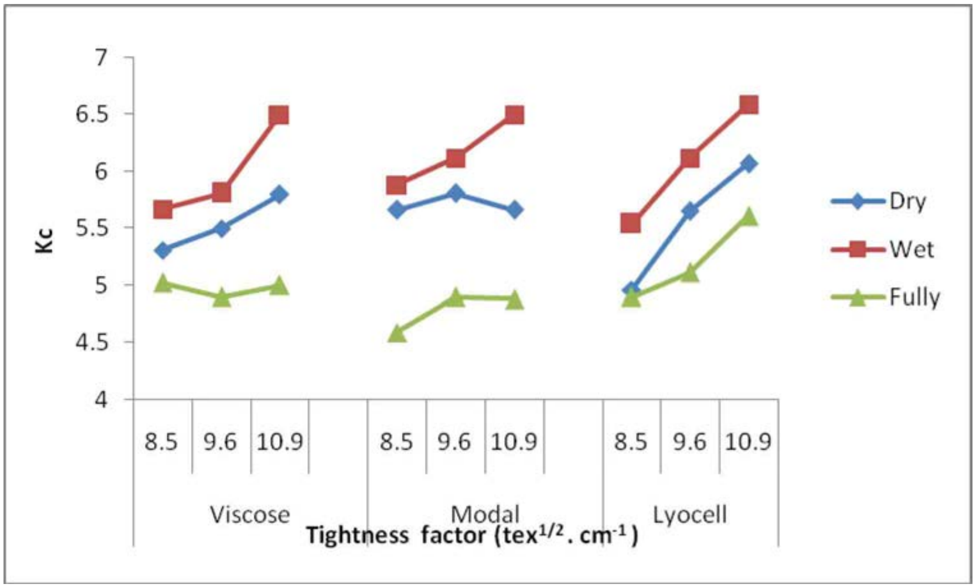

Figure 5. Relationship between Kc and tightness factor of viscose, modal and lyocell single jersey knitted fabrics

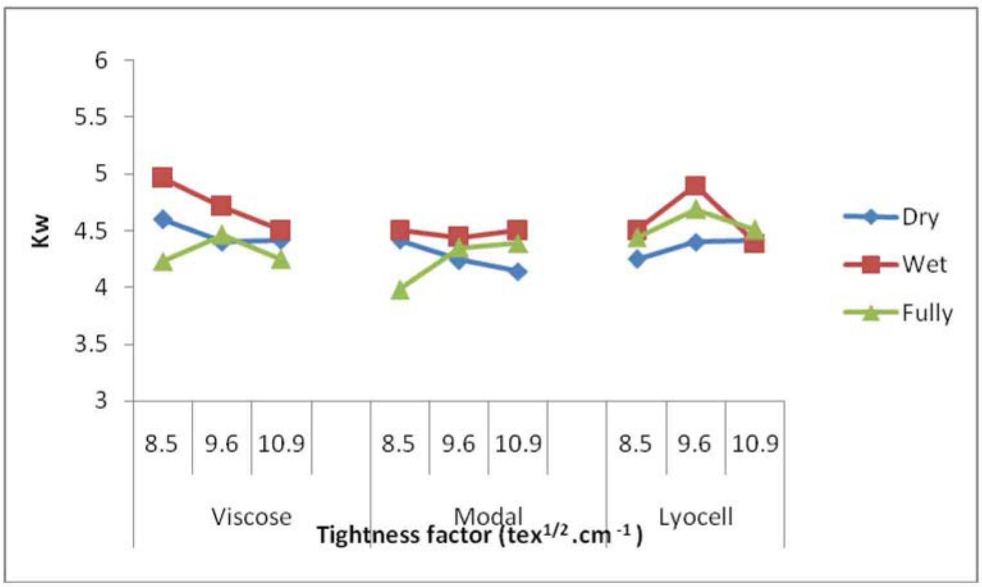

Figure 6. Relationship between Kw and tightness factor of viscose, modal and lyocell single jersey knitted fabrics

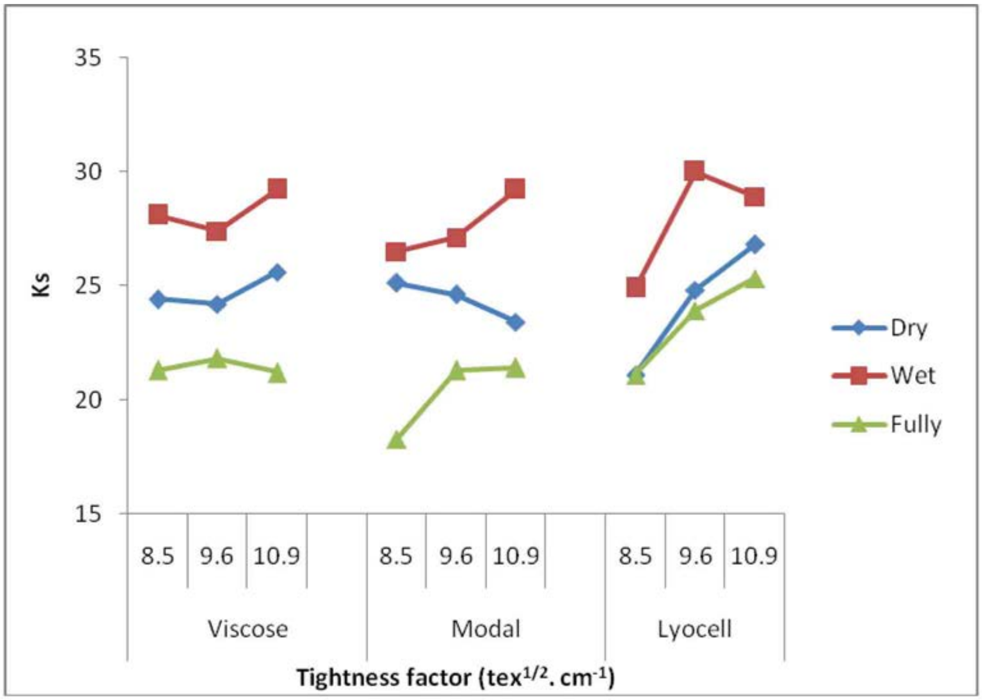

Figure 7. Relationship between Ks and tightness factor of viscose, modal and lyocell single jersey knitted fabrics

3.5 EFFECT OF VISCOSE, MODAL AND LYOCELL FIBERS ON THE FABRIC PROPERTIES

Table 2. Gives the properties of viscose, modal and lyocell fully relaxed knitted fabrics. The changes in loop shape factor of the fully relaxed fabrics made from viscose, modal and lyocell is noticeable but small. Loop shape factor is measure of the ratio of the loop width to the loop length. The fully relaxed fabric is made from lyocell shows lower spirality compare than other fabrics. It shows that, lyocell single jersey knitted fabrics have minimum distortion. Loop length significantly affects the spirality in the fabrics at 95% confidence level. It is also found that skewness of the viscose, modal and lyocell fabrics decreases with increases in loop length.

The thickness of the viscose, modal and lyocell fabric is influenced by loop length and fiber type. The loop length and fiber type has significant effect on bursting strength of the knitted fabrics. The fabrics made from lyocell shows maximum bursting strength compare than modal and viscose fabrics, it is due to the structural characteristics of lyocell fibers, reveal their good mechanical properties. The special properties of lyocell fibers is higher strength, high degree of crystalline and molecular orientation in comparison with viscose fibers.

Table 2. Properties of viscose, modal and lyocell fully relaxed knitted fabrics

Sample code	Loop shape factor	Spriality (degree)	Skweness (%)	Thickness (mm)	Bursting strength (Kg/cm^2)
V1	1.18	9	20.46	0.440	0.647
V2	1.10	7.5	16.51	0.438	0.443
V3	1.18	7	15.17	0.435	0.352
M1	1.11	8	20.02	0.441	0.844
M2	1.12	6.2	17.27	0.440	0.562
M3	1.15	6	15.29	0.436	0.422
L1	1.20	6	18.83	0.443	1.406
L2	1.10	5.5	16.27	0.440	1.055
L3	1.17	4.8	14.65	0.438	0.914

4. CONCLUSIONS

The dimensional properties of viscose, modal and lyocell single jersey knitted fabrics made with similar fiber fineness and fiber length has been investigated. The effect of the loop length and dry, wet and fully relaxation treatments on these properties was also investigated. It was noticed that for the different stage of relaxation, course and wale spacing and the loop length are linearly related. Effect of loop length on course and wale spacing of viscose, modal and lyocell single jersey knitted fabrics has significant. Lyocell fabrics show higher areal density as compared with viscose and modal fabrics.

It is also observed that the difference in the values of kc, kw of all the fabric is noticeable but small. However, ks value of the lyocell fabrics is increases proportionally with increase in the value of tightness factor, compare than viscose and modal fabrics. The loop length and fiber type has significant effect on the thickness, bursting strength and spirality of the viscose, modal and lyocell single jersey knitted fabrics. The fabrics made from lyocell shows maximum bursting strength and lower spirality as compared with modal and viscose fabric.

The lyocell yarn knitted fabric has shown greater advantages over viscose and modal yarn knitted fabrics. Single jersey knitted fabrics made with lyocell fibers shows better dimensional properties compare than viscose and modal fabrics.

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