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Effect of Stitch Length and Fabric Constructions on Dimensional and Mechanical Properties of Knitted Fabrics

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Abstract: In this experiment dimensional and mechanical properties of single jersey, single lacoste and double pique fabrics were studied under five level of stitch length. An attempt has been made to investigate the impact of stitch length and knit constructions on the dimensional and mechanical properties of knitted fabrics. The three fabrics were manufactured from 28 Ne cotton yarn by varying the stitch length. It is found that the effect of stitch length and knit structure on the properties of knitted fabric is significant. Bursting strength of single lacoste fabric is higher than other fabrics whereas double pique fabrics shows lowest bursting strength. Pilling properties of the single lacoste fabrics shows the similar trend conversely single jersey fabric shows lower resistance to pilling. Higher shrinkage in width direction is evident in single jersey fabrics while double pique fabric depicts the higher lengthwise shrinkage. Maximum spirality percentage is found in single jersey fabric than other samples.

Key words: Stitch Length · Bursting Strength · Pilling · Single Jersey · Single Lacoste · Double Pique

INTRODUCTION

Knitted goods are very popular and important part of textile materials. The reasons behind the wider uses of knitted articles are excellent elasticity, light weight, low production cost, smooth surface etc. [1]. It is required for knitted fabrics used for clothing to have very high quality. Different machines with different knit stitches and conditions are used to produce knit fabrics with different patterns and fabric types, which results in quality differences. Both the physical and mechanical properties of knitted fabrics are influenced by the structural parameters of the fabrics and finishing process [2]. Dimensional stability in terms of spirality and shrinkage are crucial in maintaining the aesthetics of knitted products in the user ends. Knitted fabrics are formed by interloping of yarn and pulling the newly formed loops through the old loops. Stretching and mechanical deformation affects the dimensional stability of the knitted fabrics. Various factors such as fiber characteristics, yarn parameters, machine parameters influence the dimensional characteristics of knitted fabrics [3]. Knitting products dimensions changes with the movements of body parts. Very wide deformation change the shapes of loop and yarn orientation as a result contact points between the loops also changes which facilitate the changes in dimensional stability of knitted fabrics. The combined effect of numerous factors such as relaxation, finishing, drying and machinery produce shrinkage in knitted articles [2].

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The impact of different knit constructions on dimensional and physical properties has been reported by many researchers [4-7]. Influence of various parameters such as yarn count, twist, stitch length, tightness factor, finishing process and washing on the dimensional properties of knitted fabric have been investigated by many researchers [8-12]. Chen et al investigated the relationship between the spirality of plain wool knitsand production factors, such as the twistcoefficient, loop length, fiber diameter and the tightness factor. They found that increasing the loop length and fiber diameter causes higher spirality [13]. Previously many attempts were made to analyze the relationship between weft knitted fabrics dimensional properties and weight related properties which are influenced by the length of stitch in the fabrics [14].

Fabric bursting strength is an important phenomenon. The fabric should have enormous bursting strength to withstand the force applied on it during different processing like dyeing, finishing and end uses. Effect of knit structures on the bursting strength is positive found by the researcher [15]. Fabric pilling is one of the severe problems in knitting industry. When pills are developed on the fabric surface results in an unsightly appearance and initiate the abrasion of the garment and can cause wear and tear of garments [16]. Within a certain range of tightness factor the number of pills increases but when the tightness factor increases number of pills decreases [17]. Several researchers investigated the relationship between knit structure and fabric pilling [5, 15 and 18].

Previously most of the researches were performed to find out the impact of different parameters on the knitted fabrics dimensional properties. But limited numbers of research have been carried out to observe the effect of yarn parameters on mechanical and dimensional properties. In order to study the effect of stitch length on dimensional and mechanical properties three different structure of knitted fabrics such as single jersey, single lacoste and double pique fabrics were manufactured. This research elucidates the effect of stitch length and various structures of knitted fabrics on the dimensional and mechanical properties.

MATERIALS AND METHODS

The objective of this study was to compare the dimensional and physical properties of single jersey, single lacoste and pique fabrics. Three structures of fabric were knitted in a circular knitting machine by varying the stitch length while other machine and yarn parameters were constant.

Sample Fabric Manufacturing: Sample fabrics were knitted on a circular knitting machine, equipped with 54 feeders; positive feed devices and adjustable fabric pulley take -down system. During preparation of fabric samples, care was taken to keep the yarn tension constant at 12cN for all the feeders. For each structure and yarn count five different stitch lengths (2.60, 2.65, 2.70, 2.75 and 2.80 mm) of fabric was knitted by adjusting the diameter of VDQ pulley.

Testing Methods: Fabric sample is cut after conditioning more or less in square shape from middle of the fabric and marked with the shrinkage template. Scaling is performed by a square template whose arm is 35 cm. Finally after sewing the measured sample washing was performed in Gyro wash machine at 40±3°C temperature for 15 min. standard soap 20g/L is used to wash the sample and dried in tumble dryer at 50°C. Then shrinkage and spirality was measured according to standard. Bursting strength of the manufactured knitted fabrics was determined by hydraulic bursting strength tester according to ISO 13938-1:1999. For pilling test a piece of fabric measured 5x5 inch is sewn so as to be firm fit when placed a rubber tube 6 inch long 1 ½ outer diameter and 1/8 inch thick. The cut ends of the fabric are covered by cellophane tape and 4 tube are placed in the box (9”x9”x9”) lined with cork 1/8 thick. The box containing the tube is then rotated at 60 r.p.m for 3 hrs. After completing 1800 cycle the extent of pilling is assessed visually comparison with the arbitrary standards 1, 2, 3, 4, 5 where 5 denotes no change in fabric surface *i.e.* zero pilling and 1 denotes the maximum pilling. The test was carried out according to ISO 12945-1:200.

RESULTS AND DISCUSSION

The dimensional and mechanical properties of single jersey, single lacoste and double pique fabrics made from 28 Ne cotton yarn have been analyzed by varying the stitch length.

Bursting Strength: Figure 1 shows the bursting strength test result of different knitted fabrics. It is noticed that there is a significant relationship between bursting strength and stitch length. Stitch length greatly influences the bursting properties of the knitted fabrics.

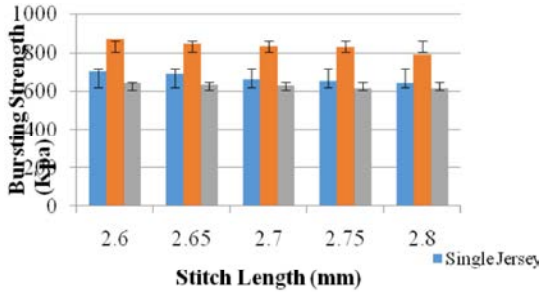

Fig. 1: Bursting strength test of knitted fabrics with different stitch length

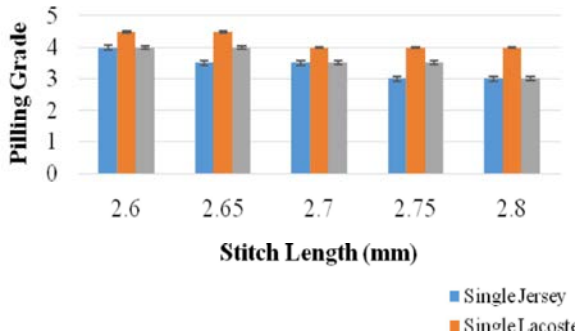

Fig. 2: Pilling test of knitted fabrics with different stitch length

With the increase of stitch length bursting strength decreases [19]. Bursting strength of single jersey fabric gradually decrease with increasing stitch length and high strength can be achieved by using small stitch length. Maximum bursting strength is found in stitch length 2.60 for single jersey, single lacoste and double pique by value 701.12 KPa, 868.64 KPa and 643.21 KPa respectively. Increase of stich length decrease the stitch density of knitted fabrics per unit area. As a result pressure exerted on the knitted fabrics is more compared to the fabric with higher stitch density. Hence, small stitch length can withstand the large pressure applied on the materials. Similarly, gradual decreasing trend is observed in both single lacoste and double pique fabrics. Bursting strength decreases with the increase of stitch length. Double pique fabrics have lower bursting strength than the single lacoste fabrics. This is due to the presence of more number of tuck stitch in double pique fabrics.

Fabric Pilling: Fabric resistance to pilling is plotted in the Figure 2. A comparative study of the results reveals that single lacoste fabrics are resistant to pilling than other fabrics. In this sample lower pill formation was observed. The overall grade of pilling resistance for all samples are gradually decreasing with the increase of stitch length

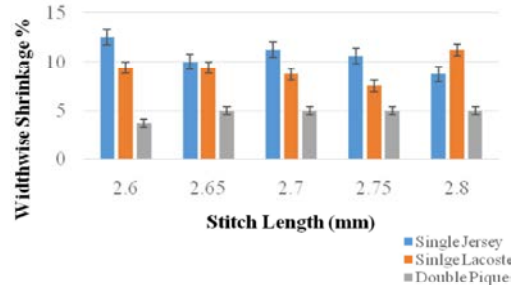

Fig. 3: Widthwise shrinkage of knitted fabrics with different stitch length

that means higher stitch length produce higher amount of pill on the fabrics surfaces. All fabrics show the same pattern except the single lacoste fabric. Single lacoste fabric demonstrate small amount of pill (pilling rate: 4.5) and resistance to pilling decreases a bit for stitch length 2.70 and remain constant till to the end i.e. further increase of stich length has no effect on the pill formations. The lowest grade of pilling 3 is reported in stitch length 2.80 mm for both single jersey and double pique fabrics. This is due to the lower stitch density of both fabrics.

Dimensional Stability: Figure 3 illustrates the widthwise shrinkage of single jersey, single lacoste and double pique fabrics. Highest shrinkage 12.5% in width direction is found for single jersey fabric on the contrary double pique fabric shows lowest shrinkage 3.75%. Single jersey fabrics are constructed with only knit loops while single lacoste and double pique fabrics are formed by both knit and tuck loops. Consequently single jersey fabric has high elasticity in width direction than the other fabrics which in turns change the dimension of the fabrics after washing. Shrinkage of the fabrics fluctuates with changing the stitch length. Shrinkage% of double pique fabrics remain constant with the increase of stitch length except stitch length 2.60mm.

Lengthwise shrinkage of different knit structure is shown in the Figure 4 below. Single lacoste fabric provides lower shrinkage than other samples. This may be due to the more compact structure of the fabrics which have lower elasticity in length direction. Less than 2% shrinkage is observed in stitch length 2.60mm and minimum shrinkage is seen at stitch length 2.80mm conversly highest 11.25% shrinkage in length direction is found at the same stich length for double pique fabrics.

The Figure 3 and Figure 4 reveals that the length wise shrinkage of single jersey fabric is better than width direction. Single lacoste fabric has very

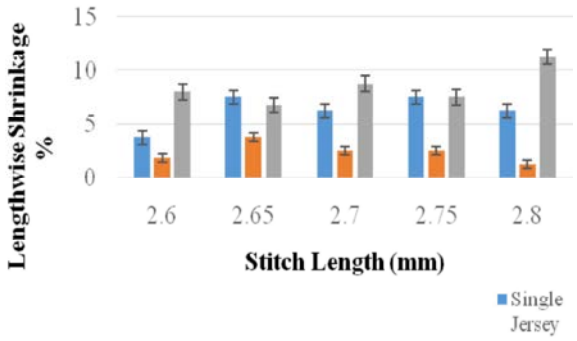

Fig. 4: Lengthwise shrinkage of knitted fabrics with different stitch length

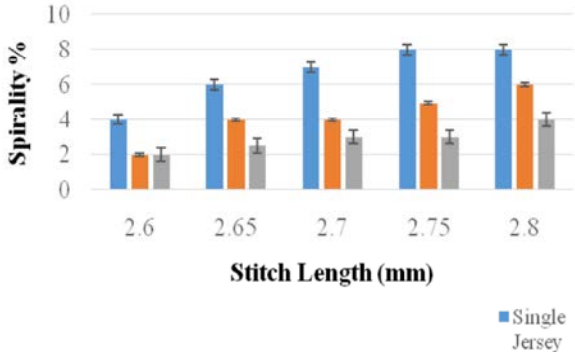

Fig. 5: Spirality of knitted fabrics with different stitch length

good resistance to shrinkage in length way while single jersey fabrics are prone to shrinkage in width direction.

Spirality percentage of various knit construction is illustrated in the Figure 5. From the figure it is seen that the percentage of spirality increases gradually with stitch length. Since the increase of stitch length decrease the number of loops per unit area of the fabrics as a result the stability of the fabrics decreases. Therefore, any force applied on the low dense fabric make it distorted very easily. Stitch length 2.60mm produces more loops on the fabric than other stitch length hence that fabric can withstand more load applied on the fabric. Single jersey fabric shows higher spirality 8% than other fabrics. This may be due to the more elastic nature of single jersey fabrics. Both the single lacsote and double pique fabrics show lower spirality percentage 2 at stitch length 2.60mm.

CONCLUSION

In this study behavior of some selected properties such as bursting strength, pilling, dimensional properties of weft knitted fabrics have been reported. Five stitch length and three structure of knitted fabrics were selected for this experiment. The machine set up and yarn count for all samples were kept constant. A significant effect of stitch length and fabric construction on the dimensional and mechanical properties were noticed. Bursting strength of three construction of fabric gradually decreases with the increase of stitch length. Therefore maximum bursting strength is achieved in small stitch length. Single lacoste fabric has the highest bursting strength than other fabrics. Fabric pilling is directly proportional to stitch length for all tested fabrics. Single jersey fabric has lower pilling resistance capacity compared to other fabrics. It is also observed that dimensional behavior varies according to fabric structure. The length wise dimensional stability of single jersey and single lacoste fabric is better than width wise. Whereas the width wise dimensional stability of double Pique fabric is better than length wise direction.Spirality of all experimental fabric is directly proportional to stitch length. Single jersey fabric has poor spirality than other fabric on the other hand double pique fabric has very good spirality properties.

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