

Effect of Knitted Structure on the Properties of Knitted Fabric

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Abstract: *Fabric structure shows great impact on different properties of weft knitted fabric if processing parameters such as; yarn count, stitch length, machine diameter, needle gauge, dyeing parameters and finishing parameters remain constant. This study investigates the effect of three weft knitted structures; plain jersey, single lacoste and double lacoste on several properties such as dimensional stability, fabric width, areal density, spirality, resistance to pilling, color fastness to washing, color fastness to light and color fastness to rubbing at finished state. From the analysis it is seen that for single jersey fabrics areal density, fabric width, resistance to pilling, width shrinkage increases with the increase of tuck stitch and spirality, length shrinkage decreases. From the investigation it is also found that fabric structure has less influence on color fastness to washing, color fastness to light and color fastness to rubbing.*

Keywords: Areal density, Dimensional stability, Fabric width, Fastness property, Pilling resistance and Spirality.

1. Introduction

Knitted structures are progressively built-up from row after row of intermeshed loops. The properties of a knitted structure are largely determined by the interdependence of each stitch to its neighbors on either side and above and below it [1]. As knit fabrics are produced on different machines with various conditions to produce different types of fabric, they bear different qualities [2]. Knitted fabric structures and finishing processes influence the physical properties and connected with the wearing properties of knitted garment [3].

Fabric pilling is one of the major problems in the knitting industry. Pills produced on the fabric surface results in an unsightly appearance and cause abrasion of the garment [4]. Resistance to pilling of the knitted fabrics depends on its density; when the stitch length decreases and surface density increases, the resistance to pilling increases [5], [6]. The effects of knit structures to pilling have been analyzed by lot of researchers [7], [8], [9].

Areal density is the measure of mass per unit area of the fabric. Usually knit fabrics with tuck stitches appear thicker than the fabric having only knit stitches due to accumulation of yarns at the tucking places [10]. The effect of knit structures on their areal density has been analyzed by many researchers [11], [12].

Knit fabric structure and machine parameter has profound influence on the fabric width. The structure with tuck stitches is wider than the normal knit structures. The loop shape at the tuck stitch is distorted and has a wider base as the side wales are not pulled together [10]. The effect of fabric structure on the fabric width has been investigated by few researchers [13], [14], [15].

Dimensional stability is very important to maintain the aesthetics of knitted products in the user ends. Different

factors such as fiber characteristics, yarn parameters, machine parameters influence the dimensional characteristics of knitted fabrics [16]. Fabric shrinkage is a serious problem originating from dimensional changes in the fabric. Yarn is exposed to various tensions during knitting process and the relaxation process changes the dimension of the knitted fabric [17]. The effect of knit structures on fabric shrinkage has not been investigated enough [11].

Spirality is a major problem of knit fabrics which is produced in circular knitting machines. Relaxation of torsional stresses cause dimensional distortions and instability in the knitted loop constructions. The effect of machine gauge, yarn and fabric properties on the spirality of single jersey knit fabrics has been analyzed by some researchers [18], [19], [20]. There have been few researches regarding the effect of knit structures on the spirality of the fabric [15].

Reactive dyes are widely used in the Bangladeshi wet processing industries due to their good fastness property. They form covalent ether linkages between the dye and the substrate while subjecting to proper condition. Few researches have been investigated the effect of fabric structures on their fastness properties [21].

The effects of various knit structures on the properties of knitted fabric have been analyzed by many researchers [3], [6], [8], [9], [11], [13], [14], [15], [16]. To the best of our knowledge, limited numbers of researches were carried out to investigate the effect of knit structure on the properties mentioned all together. The goal of this study was to find the effect of knit structures on the fabric property if processing parameters remain constant and in order to do so three single jersey structures; plain jersey, single lacoste and double lacoste were produced.

2. Material and Method

Three single jersey fabrics; plain jersey, single lacoste and double lacoste were produced from 100% cotton yarns of count 30 Ne and 22 twist per inch. The fabrics were produced in a Jiunn Long machine of the following details: model JLS2, gauge 24 GG, diameter 30 inch, feeder 84, number of needles 2258, stitch length 2.70 mm and speed 24 rpm.

After having taken the samples off the machine, they were laid on a smooth and flat surface in atmospheric condition ($20^{\circ}\text{C} \pm 2$ and $65\% \text{RH} \pm 2$) for 24 hours to allow for relaxation and conditioning. Then the grey diameter of the fabric samples was measured with a measuring tape by laying them flat on a smooth surface.

Then the samples were dyed on Unishake sample dyeing machine (Origin: Korea) with a suitable recipe. After dyeing all the samples were dried at Dilmenler tube drier (Origin: Turkey) having 8% overfeed, 140°C temperature and compacted at Tubetex tube compactor (Origin: USA) with 90% overfeed, 8% compaction, 23 rpm and finished diameter was set at 40 inch. The finished samples were conditioned in 65% RH and at 20°C before testing according to ASTM D 1776 [22].

The following properties of the fabrics were measured in accordance with the relevant standards: pilling resistance, ISO 12945-1:2000 [23]; dimensional stability test, ISO 6330:2000 [24]; spirality test, ISO 16322-3:2005 [25]; areal density, BS EN 12127:1998 [26]; color fastness to washing, ISO 105-C10:2006 [27]; color fastness to rubbing, ISO 105-X12:2001 [28] and color fastness to light, ISO 105-B02:2014 [29].

3. Results and Discussions

3.1 Effect on Fabric Weight (Areal Density)

Knitted structures have pivotal influence on fabric areal density even if the processing parameters remain same. From **Figure 1** it can be seen that with the increase of tuck loop in the fabric structure areal density is decreased in both grey and finished state.

Fabric with tuck loops are thicker than fabric having knit loops due to accumulation of yarn at the tucking place and double lacoste has higher number of tuck loops in the repeat than single lacoste fabric. So double lacoste fabric shows higher GSM than single lacoste fabric and single lacoste fabric shows higher GSM than plain jersey.

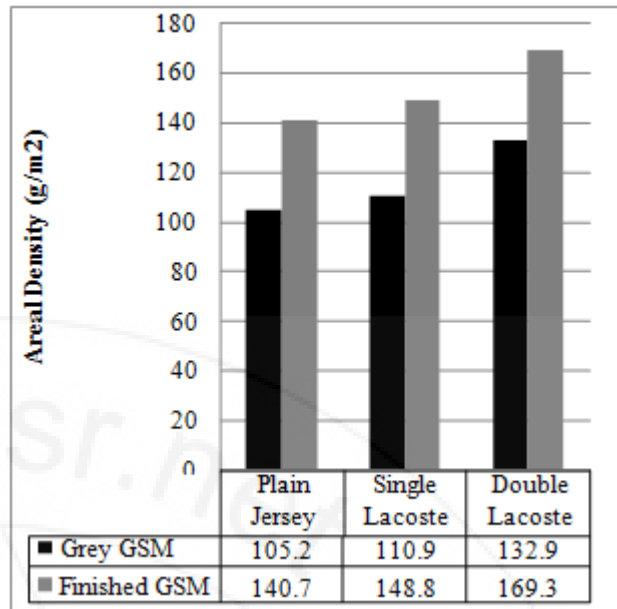


Figure 1: Areal Density of samples of different structures

3.2 Effect on Dimensional Stability

Knitted structures have important influence on the dimensional stability of the knitted fabrics. From **Figure 2** it is observed that with the increase of tuck stitch width shrinkage increases and length shrinkage decreases. Thus double lacoste has higher width shrinkage than single lacoste but less length shrinkage than single lacoste.

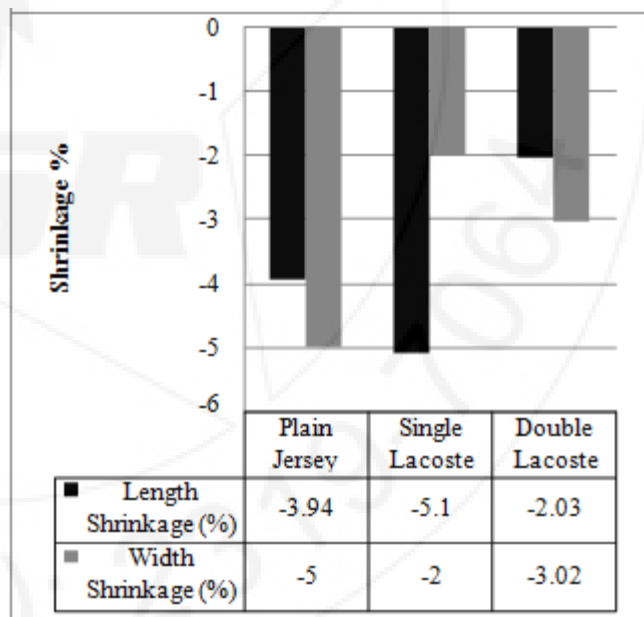


Figure 2: Dimensional Stability of samples of different structure

Table 1: Shrinkage properties of different knitted fabric

Fabric Structure	Original Dimension (cm)		Dimension after Drying (cm)		Dimensional Change %	
	Length	Width	Length	Width	Length	width
Plain Jersey			33.62	33.25	-3.94	-5
Single Lacoste	35	35	33.25	34.3	-5.1	-2
Double Lacoste			34.28	33.94	-2.03	-3.02

3.3 Effect on Pilling Resistance

The extent of pilling is assessed visually comparison with 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. From **Figure 3** it is seen that with the increase of tuck loop and areal density resistance to pilling increases. So double lacoste shows higher resistance to pilling than single lacoste and single lacoste shows higher resistance to pilling than double lacoste.

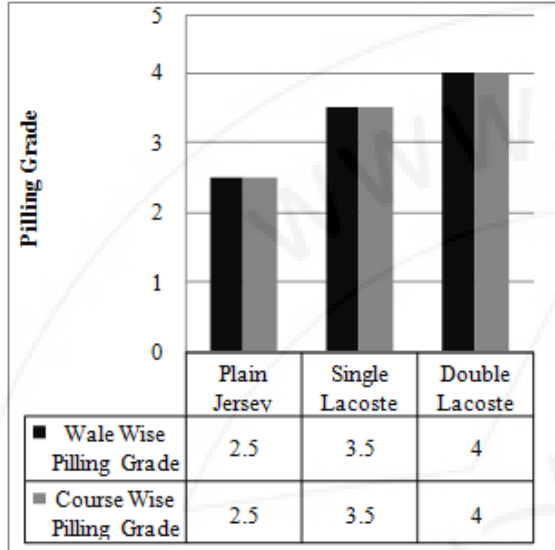


Figure 3: Pilling Resistance of samples of different structure

3.4 Effect on Fabric Diameter

Knit fabric with tuck stitches appears wider than normal knit structures. Though all the samples were finished at same diameter, to see the effect of knit structure on the fabric diameter grey diameter of the samples were taken. From **Figure 4** it is seen that with the increase of tuck loop fabric diameter increases. Therefore, double lacoste appears wider than single lacoste and single lacoste appears wider than plain jersey.

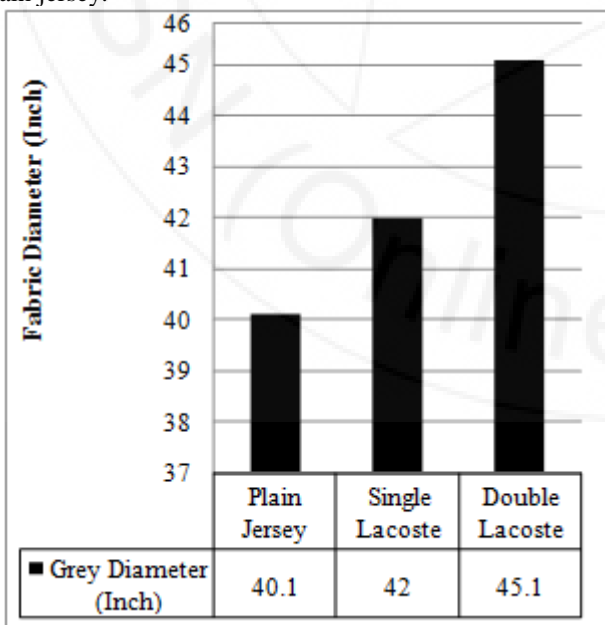


Figure 4: Diameter of samples of different structure

3.5 Effect on Fastness Properties

Knitted structures do not have major influence on color fastness to washing, color fastness to rubbing and color fastness to light of the knitted fabric if processing parameters remains same. From **Table 2**, **Table 3** and **Table 4** it can be seen that knitted structures do not have major influence on color fastness to rubbing, color fastness to light and color fastness to washing respectively.

Table 2: Color fastness to rubbing of different knitted fabrics

Fabric type	Dry rubbing	Wet rubbing
Plain jersey	4-5	3
Single lacoste	4-5	3
Double lacoste	4-5	2-3

Table 3: Color fastness to light of different knitted fabrics

Fabric type	Fastness rating according to Blue wool standard grading
Plain jersey	7
Single lacoste	7
Double lacoste	7

Table 4: Color fastness to wash of different knitted fabrics

Fabric type	Color staining						
	Color	Ac	Cot	Ny	Poly	Ac	W
	lor	eta	ton	lo	este	ryli	oo
	ch	an	te	n	r	c	l
	ge						
Plain jersey	4-5	3-4	3	3-4	3-4	3-4	3-4
Single lacoste	4-5	3	3	3	3	3	3
Double lacoste	4-5	3	3	3	3	3	3

3.6 Effect on Fabric Spirality

Spirality percentage of various knitted construction is illustrated in **Figure 5**. From the figure it is seen that with the increase of tuck loop in the knitted construction spirality decreases. Since the increase of tuck loop increases the density of the fabric as a result the stability of the fabric increases. Therefore, it is difficult for any force applied on high dense fabric to make it distorted. So double lacoste shows less spirality than single lacoste and single lacoste shows less spirality than plain jersey.

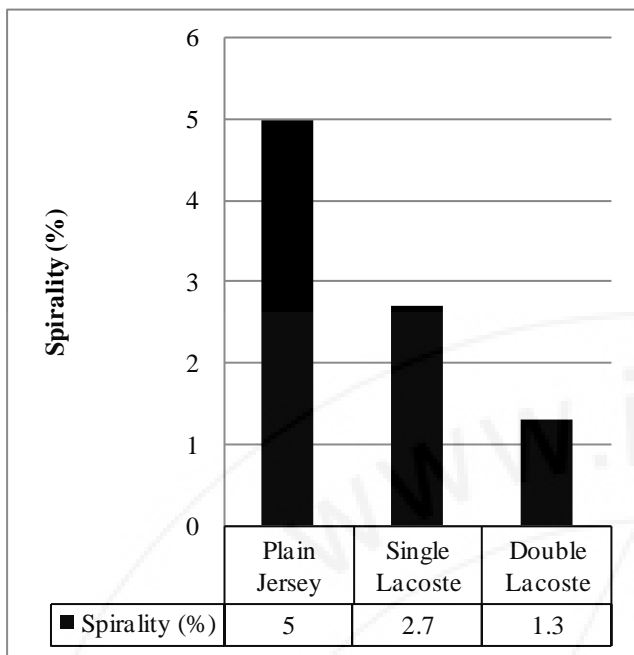


Figure 5: Spirality of samples of different structure

4. Conclusion

In this study the effect of knitted structure on areal density, fabric diameter, dimensional stability, pilling resistance, spirality, color fastness to washing, color fastness to rubbing and color fastness to light were investigated when yarn count, loop length, machine diameter, gauge, dyeing procedure and finishing procedure remains same. From the investigation it was found that with the increase of tuck loop areal density, grey fabric diameter, width shrinkage, pilling resistance increases and length shrinkage, spirality decreases. Knitted structures do not have major influence on color fastness properties if dyeing and finishing parameters remain same.

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