

AN EFFECT OF STITCH LENGTH & LYCRA PERCENTAGE ON COMFORT PROPERTIES OF KNITTED SPORT WEAR

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ABSTRACT

Knitted industries face some difficulties with reference to the selection of correct stitch length and Lycra ratio to produce a desired quality in knitted fabric. The present project work studied on the dimensional and physical properties of weft knitted structures with varying stitch length and Lycra ratio. The weft knitted structures selected for this study are plain single jersey, 1x1 double jersey rib and double jersey interlock. The basic objective of this study is to find out the behavior of fabrics made from cotton yarn alone and made from cotton Lycra blended yarns and also investigate the influence of different stitch length on properties like wales per inch, courses per inch, stitch density, fabric weight per unit area, air permeability, bursting strength, pilling, absorbency and dimensional stability. The research revealed that both stitch length and Lycra percentage significantly influenced on the properties of single jersey and double jersey weft knitted fabrics. The Lycra percentage is positively influenced on the bursting strength and fabric weight per unit area of single jersey and rib fabrics knitted with minimum stitch length. As the percentage of the Lycra increased, air permeability and absorbency of fabric were decreased. But, Lycra percentage does not show significant effect on wales per inch, courses per inch, stitch density and pilling property. The results also concluded that the wales per inch, courses per inch, stitch density, bursting strength, and fabric weight per unit area increased with minimum stitch length. The stitch length is more significantly influence on shrinkage. This study therefore assists fabric manufacturer to select the proper stitch length and Lycra percentage as per the desired quality in fabric.

KEYWORDS: *Stitch Length, Lycra Percentage, Plain Single Jersey Fabric, Double Jersey Fabric & Physical Properties*

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1. INTRODUCTION

Knitting is one of the mostly used fabrics forming technology in which fabric is formed by interlooping of yarn. The popularity and demand of knits increasing rapidly day by day due to its simple manufacturing process, high levels of comfort and produced fashion garments. Knitted fabrics are known for its high extensibility, good air permeability and moisture transport properties from the body. Now days, the technology of high performance in knitted fabrics is introduced to give multifunctional characteristics to perform in technical textiles such as sportswear, active wear, swimwear, high-tech outerwear etc. It is possible to include fabulous features by changing the different types of fibers, yarn structures, process parameters and different finishing treatments [1].

Stitch length is one of the most crucial process parameter influenced on the physical and dimensional properties of knitted fabric [2, 3]. The length of yarn consumed in one stitch is known as the stitch length. It is also

termed as a loop length. Stitch length decides the number of loops formed in unit area of fabric called as a stitch density. Quality of knitted fabric is largely depends on stitch length, as it is mainly influenced on physical properties like courses per inch, wales per inch, loop density, fabric weight per unit area, bursting strength, air permeability, absorption, Spirality and shrinkage. In case of weft knitted fabric, shrinkage is one of the most serious problems; particularly appear in single jersey fabric. This type of problem mostly occurred after fabric relaxation process. Therefore the characteristics of fabric will get change after washing/relaxation step [4]. The shrinkage of knitted fabric is also influenced on the garment sewability [5]. The presence of Lycra fibre influenced on the various properties of knitted fabrics. The fabric is tightly knitted with cotton/Lycra blended yarn with more tension which increases fabric weight, courses per inch, wales per inch, stitch density but air permeability of fabric decreases [6]. Lycra introduces extensibility into knits therefore the width of the fabric decreases results into increase in thickness of fabric. Lycra percentage is also an important process parameter [7]. Stretchability also influenced on the clothing comfort body fit, breathability and durability of cloths [8].

The present work attempts to investigate the behavior of different weft knitted fabrics on different stitch length and Lycra percentage for the observation on dimensional and physical properties. This study provides an opportunity to evaluate the relationship between stitch length and mechanical properties of single jersey and double jersey knitted fabric. The correlation analysis showed the relationship between different fabric physical and dimensional properties at three levels of stitch length and three levels of Lycra percentage. In this study, combinations of fabric samples are taken into consideration and relaxed into finished relaxation. Majorly two types of physical properties, including fabric weight per unit area and shrinkage value before wash fabric weight per unit area and shrinkage and after wash fabric weight per unit area and shrinkage would also be investigated.

2. MATERIALS AND METHODS

The present study is divided into two sections. The first section of this study consist of production of three different weft knitted structures such as plain single jersey, 1x1 double jersey rib and double jersey interlock fabric in three different stitch lengths i.e. 2.65 cm, 2.75 cm and 2.85 cm. The knitted fabrics were also produced with cotton yarn and different ratios of cotton/Lycra yarns such as 4% Lycra yarn and 7% Lycra yarn except double jersey interlock fabric. The other process parameters are kept constant during production of knitted fabrics. The second phase consists of finishing processes of fabric structures. The industrial process parameters were used during the process of heat setting, bleaching, rinsing, and neutralization, squeezing and drying.

Cotton yarn of 36 Ne yarn were used to produce different structures of weft knitted fabrics. The yarn specifications are shown in below Table 1.

Table 1: Yarn Quality

TPI	21.5
Elongation (%)	75.0
CSP	2400
Count	36.0
IPI	157.806

The specifications of circular weft knitting machine are as shown in below Table 2.

Table 2: Machine Specifications

Machine type	Pilotelli
Machine Dimensions(L*W*H)	2.3*2.2*2.5 m
Cylinder Diameter	30inch
Machine gauge	28 inch
Machine speed	28 rpm

The fabrics were bleached by hydrogen peroxide and acetic acid with caustic soda in alkaline medium. Initially wetting agent was used to wet the fabric thoroughly along with optical substance and then it was rinsed out. Also, silicon base and cationic softeners were used and finally squeezing and tumble drying were done. The temperature for drying process was 120°C and carried out at a speed of 15 meter/min. The physical properties of the produced knitted fabric were measured according to ASTM and ISO Standards on grey and finished fabric samples. The physical characteristics measured were courses per inch, wales per inch, stitch density, fabric weight per unit area, bursting strength, air permeability, absorbency and shrinkage. Table 3 shows the testing methods and equipment's used for this research work.

Table 3: Testing Methods and Equipment's

Test Parameter	Standard Test Methods	Equipment's
Fabric weight	ISO 12127	GSM Cutter and Electric Balance
Courses/inch and wales/inch	Text book method	Magnifying glass and needle
Stitch density	Text book method	N/A
Bursting strength	ASTM D 3786:2018	Tru Burst tester
Pilling	ASTM D 4970	Martindale Pilling tester
Absorbency	AATCC 79-2000	Drop Test
Air permeability	ASTM D 737-1996	MO21A SDL Atlas (at a constant pressure drop of 196 Pa & 20 cm ² Test area
Dimensional Stability	ASTM D 6207	Finished relaxation

3. RESULTS AND DISCUSSIONS

Table 4: Effect of Stitch Length and Lycra Percentage on Physical and Dimensional Properties of Single Jersey Fabric

Sr No.	Stitch Length (cm)	GSM (Before Relaxation)	GSM (After Relaxation)	Pilling Resistance			Dimensional Stability	Bursting Strength (psi)	Stitch Density	Absorbency (sec)	CPI	WPI	Air Permeability (cm ³ /cm ² /sec)
Single Jersey Fabric													
Rubs													
				125	500	1000							
100% Cotton	2.65	110	137	3	3	3	-4 x -6	79.2	2790	<9	62	45	452
	2.75	104	130	3	3	3	-5 x -4	75.9	2451	<8	57	43	510
	2.85	102	124	3	3	3	-5 x -3	72.5	2200	<10	55	40	581
With 4% Lycra	2.65	126	142	3	3	3	-5 x -2	81.4	2745	<7	61	45	436
	2.75	127	141	3	3	3	-8 x -1	79.5	2408	<8	56	43	492
	2.85	133	139	3	3	3	-9 x -1	76.1	2120	<5	53	40	572
With 7% Lycra	2.65	140	175	3	3	3	-4 x -1	83.1	2745	<6	61	45	412
	2.75	141	171	3	3	3	-6 x -1	80.2	2508	<8	57	44	482
	2.85	166	170	3	3	3	-8 x -2	77.6	2080	<6	52	40	556
Double Jersey Interlock Fabric													
100% Cotton	2.65	201	258	4/5	4/5	4/5	-6.5 x -3	99.1	3520	10	80	44	345
	2.75	195	240	4/5	4/5	4/5	-4 x -5	98.7	3000	9	75	40	378
	2.85	188	237	4/5	4/5	4/5	-6.5 x -2	89.6	2660	8	70	38	395

Table 5: Effect of Stitch Length and Lycra Percentage on Physical and Dimensional Properties of Double Jersey Rib and Interlock Fabric

Sr No.	Stitch Length (cm)	GSM (Before Relaxation)	GSM (After Relaxation)	Pilling Resistance			Dimensional Stability	Bursting Strength (psi)	Stitch Density	Absorbency (sec)	CPI	WPI	Air Permeability (cm ³ /cm ² /sec)
Double Jersey 1x1 Rib Fabric													
Rubs													
				125	500	1000							
100% Cotton	2.65	131	148	4	4	4	-5 x -9	80.2	1440	9	45	32	430
	2.75	128	147	4	4	4	-8 x -2	80	1218	8	42	29	461
	2.85	124	145	4	4	4	-7.5 x -10	77.8	1040	7	40	26	510
With 4% Lycra	2.65	170	185	4	4	4	-5 x -1	82	1504	8	47	32	418
	2.75	167	183	4	4	4	-6 x -3	81	1276	7	44	29	452
With 7% Lycra	2.85	166	180	4	4	4	-6 x -2	79	1134	7	42	27	498
	2.65	215	223	4	4	4	-5 x -5	85.5	1504	7	46	32	400
100% Cotton	2.75	214	215	4	4	4	-4 x -4	83	1204	6	43	28	446
	2.85	212	205	4	4	4	-4 x -2	80	1066	5	41	26	482
	Double Jersey Interlock Fabric												
100% Cotton	2.65	201	258	4/5	4/5	4/5	-6.5 x -3	99.1	3520	10	80	44	345
	2.75	195	240	4/5	4/5	4/5	-4 x -5	98.7	3000	9	75	40	378
	2.85	188	237	4/5	4/5	4/5	-6.5 x -2	89.6	2660	8	70	38	395

3.1 Effect of Stitch Length and Lycra Percentage on Courses/Inch, Wales/Inch and Stitch Density of Weft Knitted Fabrics

The table 4 and 5 revealed the influence of stitch length and Lycra percentage on structural property of weft knitted fabrics such as wales per inch, courses per inch and stitch density. The results concluded that stitch length is adversely effect on wales per inch, courses per inch and stitch density but presence of Lycra does not show significant correlation. As the stitch length decreased, more number of loops formed per unit area of fabric, results in increased stitch density.

3.2 Effect of Stitch Length and Lycra Percentage on Pilling of Weft Knitted Fabrics

It is apparent from the table 4 and 5 that the above tabulated value obtained from Martindale Pilling tester shows that rating is not influenced by the use of Lycra yarn and stitch length.

3.3 Effect of Stitch Length and Lycra Percentage on Air Permeability of Weft Knitted Fabric

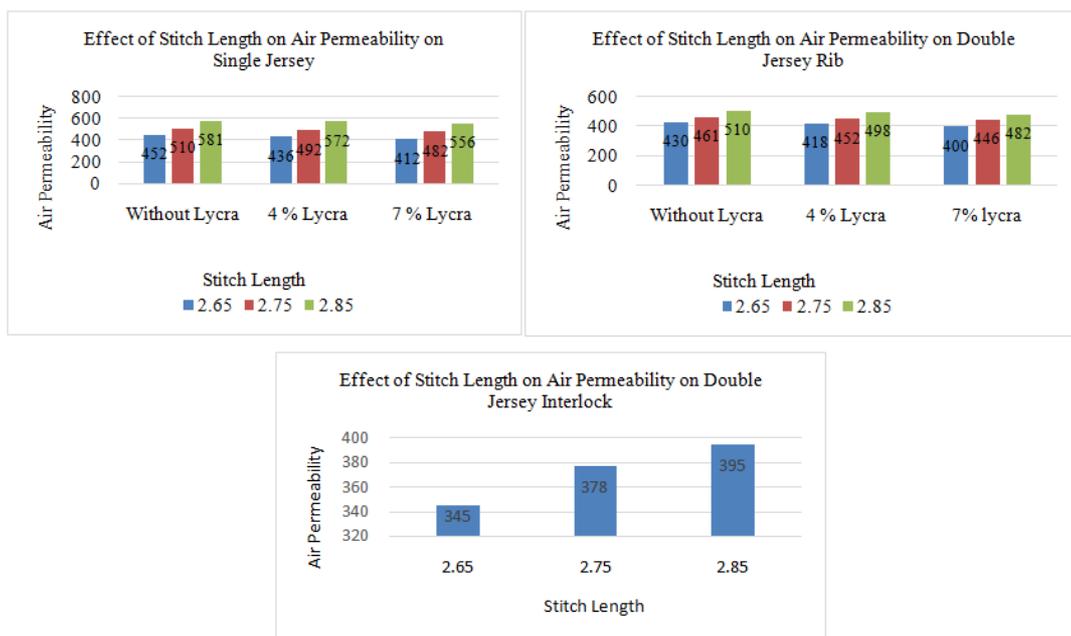


Figure 1: Effect of Stitch Length and Lycra Percentage on Air Permeability of Weft Knitted Fabric

From the above Table 4 and 5, and Figure 1 it is concluded that stitch length is directly proportional to the air permeability of single jersey and double jersey rib and interlock fabric. Air permeability value found more in all weft knitted fabrics for highest stitch length i.e. 2.85cm. This is attributed due to the fact that lower stitch length increases the stitch density which means more fabric tightness and fine pore diameter in addition to the increase in the fabric thickness. Single jersey fabric shows highest air permeability than double jersey rib and interlock fabric because of geometry of single jersey fabric consists of single loop structure with greater pore size and hence it is more extensible and looser structure than double jersey. The results also found that as the Lycra percentage increased from 4% to 7%, air permeability decreased in both single jersey and 1x1 rib fabrics. Air permeability is greatest for cotton fabric than cotton/Lycra blended fabric because tighter structure is produced with Lycra yarn.

3.4 Effect of Stitch Length and Lycra Percentage on Bursting Strength of Weft Knitted Fabric

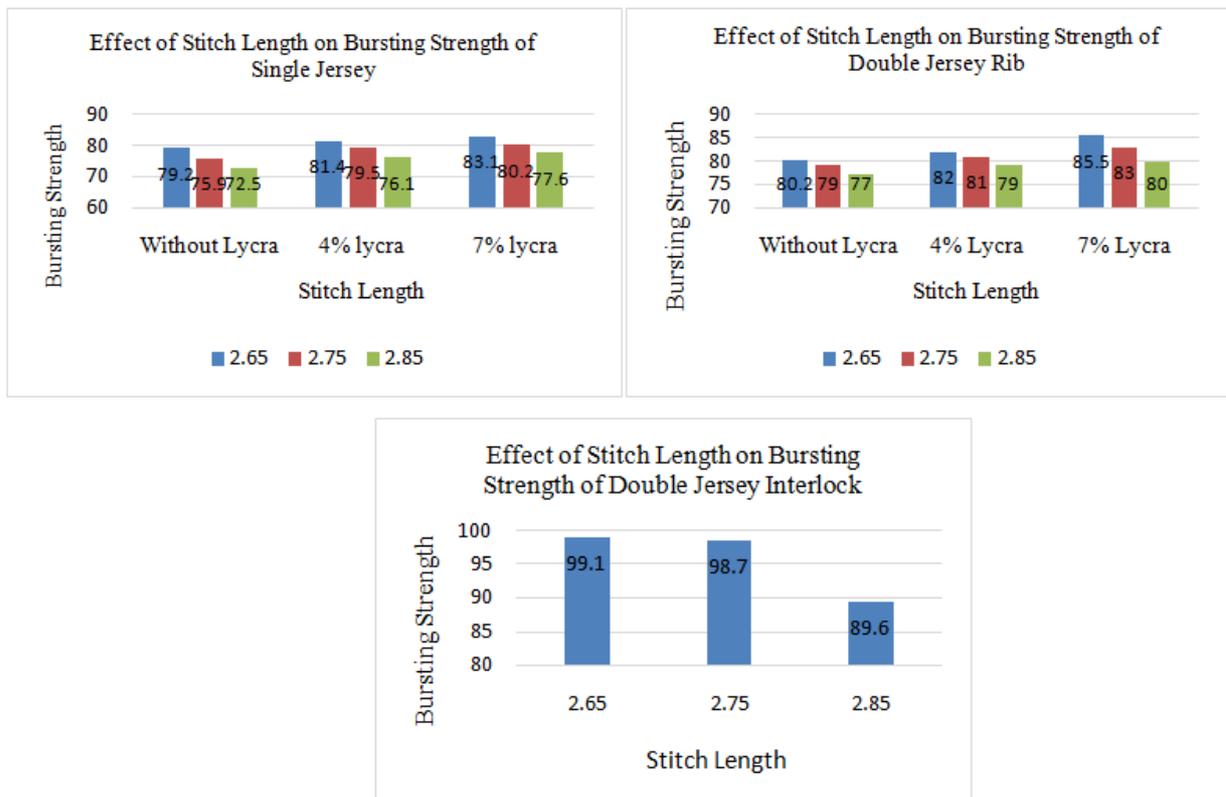


Figure 2: Effect of Stitch Length and Lycra Percentage on Bursting Strength of Weft Knitted Fabric

It is clear from the Figure 2 that bursting strength increased with decreasing the stitch length. Similar results were found for single jersey, plain rib and interlock fabric. This is because as the stitch length increases the knitted fabric becomes more open and lighter in weight as compared with the small loop length. The behavior of bursting strength is different for cotton and cotton/Lycra blended knitted fabric. By increasing the Lycra percentage from 4% to 7% the bursting strength increased in all types of knitted fabric. This means that Lycra yarn causes the increase of the bursting strength of fabric due to the higher compactness introduced in knitted fabric. This happened because Lycra yarn holds the loops together and the fabric becomes less open and this increases the compactness.

3.5 Effect of Stitch Length and Lycra Percentage on Absorbency of Weft Knitted Fabric

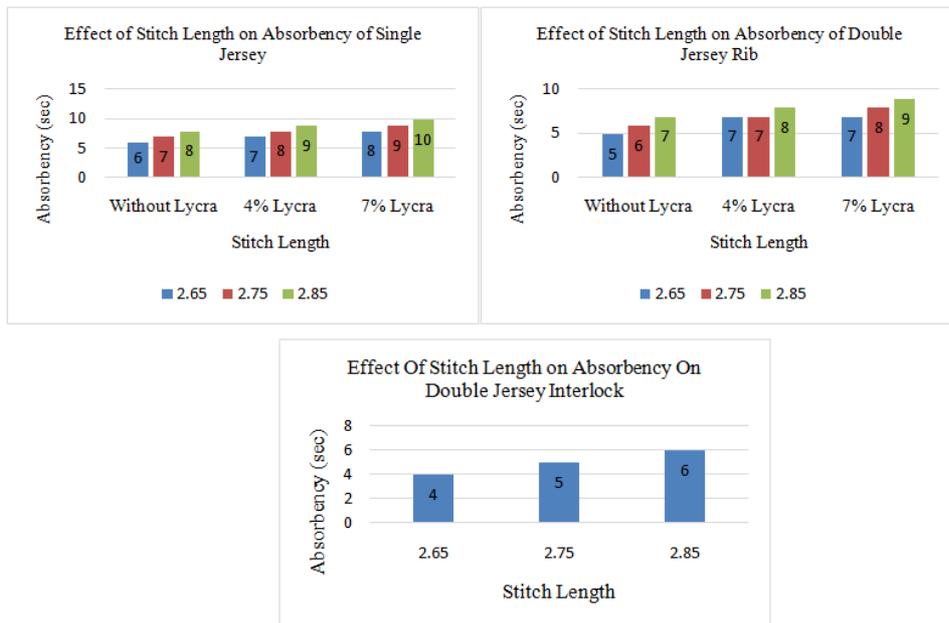


Figure 3: Effect of Stitch Length and Lycra Percentage on Absorbency of Weft Knitted Fabrics

The Figure 3 clearly indicates the stitch length is significantly influenced on the absorbency of single jersey and double jersey rib and interlock fabrics. Absorbency found more at 2.65 cm stitch length whatever the percentage of Lycra included in all knitted fabrics. The results concluded that as the loop length increases fabric density decreases therefore the absorbency of the fabric decreases. The absorbency of 100% cotton fabric found more than Lycra/cotton blended fabric. This means that Lycra percentage decreases the absorbency of single jersey and double jersey knitted fabrics.

3.6. Effect of Stitch Length and Lycra Percentage on Dimensional Stability of Weft Knitted Fabric

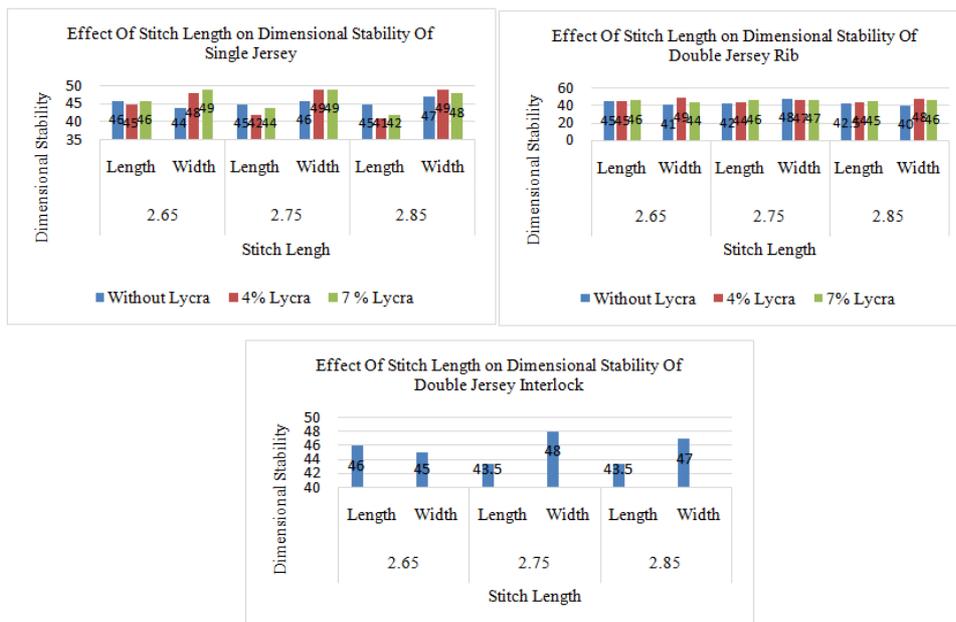


Figure 4: Effect of Stitch Length and Lycra Percentage on Dimensional Stability of Weft Knitted Fabric

From the above Figure 4, it reveals that the lengthwise shrinkage is less than widthwise for single jersey and double jersey fabric and both lengthwise and widthwise shrinkage is increased due to the increase of stitch length. The shrinkage percentage of cotton/Lycra fabric is less than the 100% cotton single jersey and double jersey fabric. Because Lycra fiber helps to retain the fabric's original dimension as far as possible after washing.

3.7 Effect of Stitch Length and Lycra Percentage on GSM of Weft Knitted Fabric

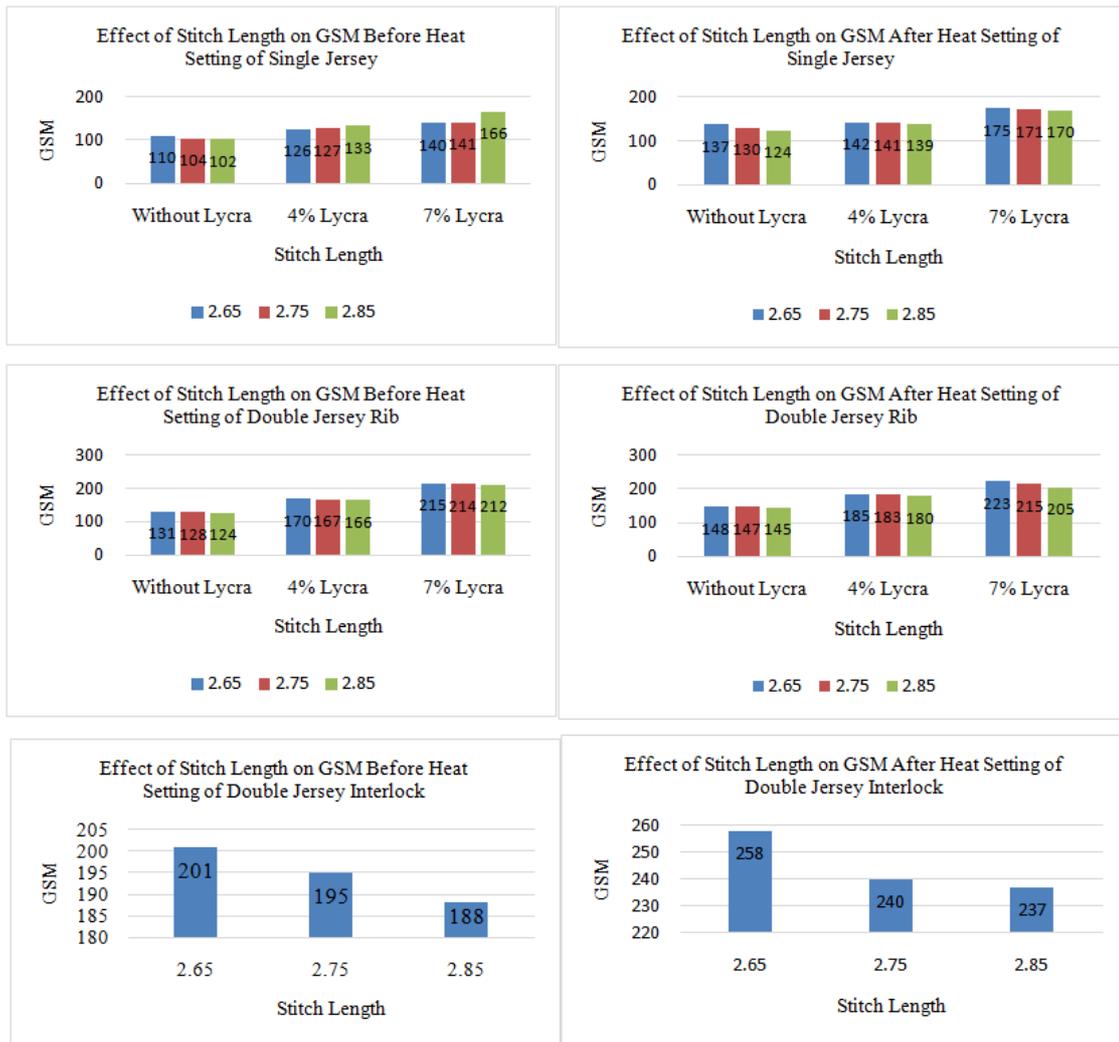


Figure 5: Effect of Stitch Length and Lycra Percentage on GSM of Weft Knitted Fabric

The effect of knitting stitch length and Lycra percentage on the weight of Single jersey and double jersey rib and interlock knitted fabric before finishing and after finishing is shown in Figure 5. The results from table 4 and 5 showed that, there is direct relationship between stitch length and Lycra percentage in the structure (from 0% to 7%) and fabric weight. It is clear that, the weight of the single jersey as well as double jersey knitted fabric increases with the increase in stitch length from 2.65 cm to 2.85 cm due to increase in stitch density, the courses become far away from each other and consequently the course density decreases. But the presence of Lycra increases the fabric weight slightly increases due to the presence of Lycra yarn. The results also concluded that the finishing also significantly influenced on the fabric weight. After finishing process the loops becomes relaxed due to removal of yarn tension and hence the fabrics become more compact results into increased in weight.

4. CONCLUSIONS

The results obtained in this study concluded that, fabric dimensional and physical properties change as different stitch lengths are knitted, when using lower stitch length the fabric is wider, thicker and heavier while using higher stitch length, the fabric is narrower, thinner and lighter. It was obvious that, the stitch length has a significant influence on the fabric weight, bursting strength and air permeability for all wefts knitted samples like single jersey, 1x1 rib and plain interlock. This is in case of 100% cotton, while by adding Lycra yarn the knitted fabric becomes tight and the fabric weight increases as the percentage of Lycra increases; that is, the loop length has no significant effect on the fabric weight. By introducing the Lycra yarn in knitted fabric air permeability of knitted fabric decreases. The higher air permeability rate the quickest heat-loss obtained from a textile material. For summer wear, structures with higher stitch length knitted with 100 % cotton yarn could be used as it is characterized by higher air permeability, creating a cool feeling to the wearer by allowing more cold air to penetrate through to bring the heat away from the body and accelerate the sweat evaporation at the skin and fabric surface.

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