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Performance Characteristics of Knitted Fabrics Made from 100% Cotton and Cotton/Elastane Blended Yarns

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ABSTRACT

The study focuses on the performance characteristics of single jersey, single pique, two thread fleece, 1x1 rib and interlock knitted fabrics in relation to Elastane yarn presence in the combed cotton yarn. An Elastane yarn accounts for about 5% content (40 denier = 133Ne) while cotton accounts for 95% content (35 Ne) in the 28Ne combed cotton/Elastane blended yarn (cotton/Elastane = 95/5%) and the Elastane is plied with the cotton yarn. The comparison was done between cotton/Elastane yarn knitted fabrics and 100% cotton yarn knitted fabrics and within the structures. The tests have been done on the bursting strength, abrasion and pilling resistances of single jersey, 1x1 rib, single pique, two thread fleece and interlock knitted fabrics using digital bursting strength tester and Martindale abrasion and pilling tester by conditioning for 24 hours at 21^{o}c±1 and 65±2% RH. As found from the study, the presence of Elastane yarn influences significantly by decreasing the bursting strength and increasing an abrasion resistance of the five knitted fabrics. The pilling resistance of knitted fabrics such as 1x1 rib and interlock decreased while single jersey, single pique and two thread fleece knitted fabrics increased significantly due to 5% Elastane yarn in 95% combed cotton yarn.

Keywords: bursting strength, abrasion, pilling resistance, knitted fabrics, Elastane yarn, cotton yarn and cotton/Elastane blended yarn

INTRODUCTION

The type of yarn used during knitting determines the characteristics and applications of knitted fabrics. Knitted fabrics have soft hand feel, form fitting and good extensibility with reasonable strength properties. Some knitting technologists, advises the use of elastic yarns such as Elastane/spandex/ in order to improve the extensibility and shape fitting properties of knitted fabrics. The use of spandex yarn is improving not only the extensibility and body shape fitting but also other physical properties will also be influenced.

The performance characteristics of knitted fabrics are very important in many ways for determining its end use. Among these properties the bursting strength, abrasion and pilling are extremely important for determining its applications (R.A.M. Abd El-Hady, 2016). Bursting strength is the force that must be exerted perpendicularly on the fabric surface to break off fabric (Mavruz S., 2007). Bursting strength is an alternative method of measuring strength in which the material is stressed in all directions (Marmaral, 2003). Many researchers have investigated bursting strength of knitted fabrics by taking into consideration the different parameters of knitted fabrics. The bursting strength varies according to different parameters such as spinning technology, fabric structure, raw material- blended materials with cotton, and machine settings (B.A.Saber, 2009; C.N Herath, 2007; C.N.Herath, 2008). Bursting strength of cotton/Elastane fabric is higher than 100% cotton single jersey because the use of Elastane helps the fabric to expand more than the 100% cotton single jersey and it needs more pressure and more time to burst the sample (AnwarulAzim, 2014; P.Pramanik, 2009). Elastane yarn causes an increase in the strength of the fabric due to the higher compactness in the fabric structure resisting the bursting force (Bayazit, 2003; El-Hady, 2016; R. Sadek, 2012; R.A.M. Abd El-Hady, 2016).

The resistance of textile materials to abrasion as measured on a testing machine in the laboratory is generally only one of several factors contributing to wear performance or durability as experienced in the actual use of the material. While “abrasion resistance” (often stated in terms of the number of cycles on a specified machine, using a specified technique to produce a specified degree or amount of abrasion) and “durability” (defined as the ability to withstand deterioration or wearing out in use, including the effects of abrasion) are frequently related, the relationship varies with different end uses, and different factors may be necessary in any calculation of predicted durability from specific abrasion data (ASTMD4966, 2012).

The abrasion mechanism of textiles is a complex phenomenon and associated with the properties of fibers, yarns, fabric structure and applied treatments. Abrasion in textiles such as fabrics, yarns, socks and technical textiles can be measured by different methods. Due to the technological improvements and growing demands on the properties of textile materials, it seems the development of new test techniques and equipment will continue on this issue(Nilgün Özdil, 2012). Textile materials can be unserviceable because of several factors and one of the most important cause is abrasion. Abrasion occurs during wearing, using, cleaning or washing process and this may distort the fabric, cause fibers or yarns to be pulled out or remove fiber ends from the surface (Hu, 2008; Kadolph, 2007).

Products of knitted fabric are characterized as being elastic, resilient and soft, they have good draping properties, and cling well to body to inhibit movement. However, during exploitation, pills form on the surface of the knitted fabric, remaining on the surface of the product and worsening its exterior. The process of formation of pills consists of three stages (Gykytė I., 2002): due to mechanical impact to the surface of rasped products, firstly, the tips of several fibers of fiber are pulled out creating a fuzzy surface. Later, broken fibers grip to felt tips and forms separate, gradually growing pills. Fibers holding these pills are griped strongly, later however, due to the further mechanical impact (attrition, washing and other) they may rub away and fall off.
The resistance of knitted fabrics to pilling depends on the density of fabric, i.e. when the length of knitted fabric loop decreases and the surface density increases, the resistance to pilling grows (Gita BUSILIENĖ, 2011; Mikučionienė, 2009).

(Sadek R., 2012) reported their findings of abrasion resistance in weight loss % as the fabric weight loss % in the case of half

plating is greater than that of the 100% cotton fabric by an average of 7.5 %. The fabric weight loss% in the case of the full plating is less than 100 % cotton fabric by an average decrease of -15 %. The increase in weight loss% in the case of the half plating may be interpreted by the ridges formed on the fabric surface due to the absence of Elastane in half of the courses. These ridges are not formed on the fabric surface in the case of the full plating and the surface is more regular.

Pilling increased as polyester content of the blends increased and the majority of the fibers in the pills were polyester (Ichetaonye, 2013). The pilling grades of both the samples are same. Therefore presence of Elastane doesn't affect the pilling property of knitted fabrics (Abu Yousuf Mohammad Anwarul Azim, 2014).

As reviewed from research articles and books, Elastane yarn effect on knitted fabrics performance characteristics have not been investigated in detail. Its effect on different structures of knitted fabrics (other than single jersey) has not been studied. The previous studies did not mention whether an Elastane yarn was blended with combed yarn or carded yarn. In addition, the structure investigated by different scholars was only single jersey which is impossible to conclude an elastane effect on other knitted structures. And, many of them use Elastane as core and plied yarn with cotton ring spun yarn whereas in this research, Elastane is used as a naked filament (not skin friendly with the cotton yarn) and fed to the needles with a separate yarn carrier. This research focuses on the effect of Elastane yarns on five different knitted fabrics (single jersey, single pique, two thread fleece, 1x1rib and 1x1interlock) performance characteristics. The fabrics were knitted from 100% cotton and 95/5% cotton/Elastane blended yarns and investigated for their performance characteristics.

1. MATERIAL AND EXPERIMENTS

1.1. Materials

100% cotton and Cotton/Elastane blend yarns are used for this study. An Elastane accounts for about 5% contents (40denier = 133Ne) while cotton accounts for 95% content (35Ne) in the 28Ne combed cotton/Elastane blended yarn (cotton/Elastane = 95/5%) and an Elastane is feed to the needles as naked filament with the cotton yarn in the same yarn feeder (carrier) but neither plied nor core spun with cotton. Cotton fiber harvested from Upper Awash-Ethiopia has 28mm staple length, 12.8 short fiber index, 300 neps, 4.06trash percent, 4.2 Micronaire fineness. The yarns used for this study are 100%cotton and cotton/Elastane blended. The cotton yarn has 750m-1 twist, 28 Ne count, 9.21% U%, 11.70 CVM, 0 thin-50%, 33.6 thick+50%, 29.8 Neps+200% and 63.4 total imperfection percent. The single jersey, single pique and two thread fleece are produced by the single bed circular knitting machine with 30rpm, 34" diameter, 2976 needles, 4 cam tracks and 108 feeders. 1x1Rib/interlock is produced by double bed circular knitting machine with 20/14rpm, 30" diameter, 2630 needles, 94/112 feeders, 1/2 cam tracks respectively. The study was carried out by keeping these materials and their parameters constant except for the yarn's (raw material type).

In the single jersey, 1x1rib, interlock, single pique and two thread fleece knitted fabrics, the loop lengths were set equal in the knitting machine. But, during the knitting process the fabrics will have different loop lengths due to transferring of the loop and staying idles in the rib and interlock knitting machines, held and ticked loops in single pique and the floats at the technical back of fleece knitted fabrics. There are 28 needles per inch in a cylinder in single jersey, single pique and fleece. In 1x1rib knitting machines there are 18 needles per inch in cylinder and 18 needles per inch in dial. In interlock knitting machines there are 24 needles per inch in cylinder and 24 needles per inch in dial. The working principle and arrangement of needles in

1x1rib and interlock knitting machines is different in gaiting (Spencer, 2001).

2.2 Experiments

Single jersey, 1x1rib, interlock, single pique and two thread fleece knitted fabrics were produced for this study. Bursting strength, abrasion and pilling resistances of single jersey, 1x1rib, interlock, single pique and fleece (two thread fleece) knitted fabrics made from 100%cotton and cotton/Elastane yarns have been designed for this study.

i. Yarn properties: The yarn properties tested were U% (irregularity), CVM (coefficient of variation in mass), Thin and Thick places and the amount of Neps in cotton yarn. This was done using Uster tester-5 machine and Uster testing standards. Five specimens are tested and the average results are shown in Table 2.
ii. Bursting strength: The bursting strength of single jersey, 1x1rib, interlock, single pique and fleece knitted fabrics were tested using digital bursting strength tester as directed in ASTM D3786-01, termed as Standard Test Method for Hydraulic Bursting Strength of Textile Fabrics—Diaphragm Bursting Strength Tester method(ASTM, 2013).
iii. Abrasion resistance: The abrasion resistance of single jersey, 1x1rib, interlock, single pique and fleece knitted fabrics were tested using martindal abrasion tester as directed in ASTM D4966-98 with option 1 in which the end point is reached when one hole is formed in knitted fabric in Martindale abrasion tester using standard abradant fabric, felts and polyurethane foam backing (ASTMD4970, 2015). The weight used in this test to give the required pressure is 9Kpa and each sample fabric subjected for 5000 rotations at maximum speed.
iv. Pilling resistance: The pilling resistance of single jersey, 1x1rib, interlock, single pique and fleece knitted fabrics were tested using martindal pilling tester as directed by ASTM D4970 termed as Standard Test Method for Pilling Resistance and Other Related Surface Changes of Textile Fabrics: Martindale Tester'. The fabric is in its raw state or tested before washing subjected for 100 movements. The rating standard is used for rating of individual specimens for pilling. The weight used in this test to give the required pressure is 12KPa (ASTMD4970, 2015).

3. RESULTS AND DISCUSSION

3.1. Bursting strength

Bursting strength of single jersey, 1x1rib, interlock, single pique and fleece knitted fabrics made from 100%cotton and cotton/Elastane yarns have been studied and the results are shown in Table 2. The bursting strength of single jersey, 1×1rib, interlock, single pique and fleece knitted fabrics made from 100% cotton and cotton/Elastane (95/5%) blended yarns is different. The bursting strength of single jersey, 1x1rib, interlock, single pique and fleece knitted fabrics made from 100%cotton has higher bursting resistance as compared to the same fabrics made from cotton/Elastane blended yarn. The bursting strength of 1x1rib knitted fabric made from 100%cotton has higher as compared to other knitted fabrics made from the same material while fleece made from cotton/Elastane has greater bursting strength as compared to other fabrics made from the same material. This is due to 1x1rib knitted fabric has greater widthwise extensibility than the other knitted fabrics while fleece has two floats at the back of the fabric which are broken before bursting has taken place that improves the bursting time and resistance of knitted fabrics. Interlock knitted fabric has the lowest bursting strength as compared to other knitted fabrics because the interlock knitted fabric is made when two 1x1rib structures locked together and this reduces the extensibility of interlock knitted fabrics.
The bursting strength of single jersey, 1x1rib, interlock, single pique and fleece knitted fabrics is reduced due to the presence of 5% Elastane in 95% cotton yarns. This is due to the high shrinkage rate of these fabrics by the presence of Elastane yarns in the structure. As reviewed in different literature, the

bursting strength of single jersey increased due to Elastane yarn. But, in this research bursting strength of knitted fabrics made from cotton/Elastane is lower than the same fabrics made from 100%cotton because of an Elastane yarn is knitted on needles as naked filament whereas in other researches as core ring spun yarn. Here we can conclude that in addition to an Elastane content influences the knitted fabrics bursting strength (resistance), the spinning (blending) and feeding method of cotton/Elastane yarn also affects the property.

Table 1: Relationship of bursting strength with some of dimensional properties of knitted fabrics

Type of Fabric	Wales per cm	Thickness (mm)	Shrinkage in %	Bursting Strength in Bar
Single jersey (100% cotton)	14	0.621	22.348	6.38
Single jersey (Cotton/Elastane)	16.9	0.75	34.545	4.637
1x1rib (100% cotton)	12.06	0.835	70.677	7.313
1x1Rib (cotton/Elastane)	17.5	1.325	79.74	5.433
Interlock (100% cotton)	12.98	1.253	27.198	6.05
Interlock (cotton/Elastane)	20.94	1.495	54.789	4.36
Single pique (100%cotton)	12.15	0.747	9.258	6.351
Single pique (cotton/Elastane)	15.37	1.032	28.264	5
Fleece (100% cotton)	11.14	0.924	1.004	7.186
Fleece (cotton/Elastane)	14.43	1.43	23.575	5.956

The ascending order of bursting strength of the five knit structures made from 100%cotton is interlock, single pique, single jersey, fleece and 1x1rib knitted fabrics (see Table 2) while interlock, single jersey, single pique, 1x1rib and fleece are in the ascending order of bursting resistance of knitted fabrics made from cotton/Elastane yarn. In Table 2, the mean, standard deviation, standard error, minimum and maximum values of test specimens are shown. The standard deviations of single jersey, 1x1rib and fleece knitted fabrics are reduced because of the presence of 5% Elastane in 95% cotton yarn while interlock and single pique have a higher standard deviation with the same Elastane content in cotton than 100%cotton yarn. This is due to the values in a statistical data set shows different closeness to the mean of the data set, on average.

Table 2: Description for bursting strength of knitted fabrics made from 100%cotton and cotton/Elastane

		N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Bursting strength of single jersey	95.00	10	4.6370	.15312	.04842	4.39	4.87
	100.00	10	6.3800	.38035	.12028	5.64	6.91
	Total	20	5.5085	.93761	.20966	4.39	6.91

Bursting strength of 1x1rib	95.00	10	5.4330	.17914	.05665	5.20	5.71
	100.00	10	7.3130	.37523	.11866	6.50	7.70
	Total	20	6.3730	1.00598	.22494	5.20	7.70
Bursting strength of interlock	95.00	10	4.3600	.35746	.11304	3.87	4.99
	100.00	10	6.0500	.21828	.06902	5.74	6.38
	Total	20	5.2050	.91362	.20429	3.87	6.38
Bursting strength of pique	95.00	10	5.1340	.12642	.03998	4.88	5.33
	100.00	10	6.3510	.11599	.03668	6.14	6.53
	Total	20	5.7425	.63538	.14207	4.88	6.53
Bursting strength of fleece	95.00	10	5.3820	.08189	.02590	5.25	5.50
	100.00	10	7.1860	.10069	.03184	6.98	7.31
	Total	20	6.2840	.92973	.20789	5.25	7.31

The bursting strength of single jersey, 1x1rib, interlock, single pique and fleece knitted fabrics mean differences are significant at 0.05 levels. As shown in Table 3, the bursting strength of single jersey is significantly influenced by the presence of 5% Elastane in the Upper Awash combed cotton ring spun yarn (F = 180.716; Sig. = 0.000000). 1x1Rib (F = 204.429; Sig. = 0.000000), interlock (F = 162.813; Sig. = 0.000000), single pique (F = 503.144; Sig. = 0.000000) and fleece (F = 1932.041; Sig. = 0.000000) knitted fabrics are significantly influenced by Elastane yarns. Fleece has greater F-Value as compared to other knitted fabrics which shows that fleece has a high dispersion rate as compared to other knitted fabrics.

Table 3: Analysis of variance for bursting strength of knitted fabrics made from 100%cotton and cotton/Elastane yarns

		Sum of Squares	Df	Mean Square	F	Sig.
Bursting strength of single jersey	Between Groups	15.190	1	15.190	180.716	.000000
	Within Groups	1.513	18	.084		
	Total	16.703	19			
Bursting strength of 1x1rib	Between Groups	17.672	1	17.672	204.429	.000000
	Within Groups	1.556	18	.086		
	Total	19.228	19			
Bursting strength of interlock	Between Groups	14.281	1	14.281	162.813	.000000
	Within Groups	1.579	18	.088		
	Total	15.859	19			
Bursting strength of pique	Between Groups	7.405	1	7.405	503.144	.000000
	Within Groups	.265	18	.015		
	Total	7.670	19			
Bursting strength of fleece	Between Groups	16.272	1	16.272	1932.041	.000000
	Within Groups	.152	18	.008		
	Total	16.424	19			

3.2 Abrasion Resistance of Knitted Fabrics

Abrasion resistance of single jersey, 1x1rib, interlock, single pique and fleece knitted fabrics were studied and the results are shown in Table 4. The abrasion resistance of single jersey, 1×1rib, interlock, single pique and fleece knitted fabrics made from 100% cotton and cotton/Elastane (95/5%) blended yarns is different. The abrasion resistance of single jersey, 1x1rib, interlock, single pique and fleece knitted fabrics made from 100%cotton is lower as compared to the same fabrics made from cotton/Elastane blended yarn. The abrasion resistance of single jersey knitted fabric made from 100%cotton and cotton/Elastane is highest as compared to the other knitted fabrics made from the same yarns. Because, single jersey knitted fabric is exposed to rubbing (abrasion) in its technical face loops, but the technical back loops are hidden. The technical face loops are smooth and the loop parts such as loop arm (stem) is visible and subjected for abrasion while head and feet of loop are hidden at the back of the fabrics for friction or rubbing. The technical face loops are resistant to abradant and the fabric appearance and service will be better with face loops than back loops. Interlock and fleece knitted fabrics made from 100%cotton and cotton/Elastane yarns have the lowest bursting strength as compared to other knitted fabrics because the interlock knitted fabric is made when two 1x1rib loops are locked together using two yarns from separate feeders to form a four loop one interlock stitch. This increases the thickness of interlock fabrics by increasing the yarn diameter that leads to low friction (abrasion) resistance of knitted fabrics. Fleece knitted fabric made from 100%cotton and cotton/Elastane yarn is a two thread fleece fabric. The fleece floats at the back of the fabric and connected to the meshed loops. The fibers from the float yarns at the technical back of knitted fabrics protrude and removed easily during abrasion with other objects. This leads to poor appearance and service life of knitted fabrics.

The abrasion resistance of single jersey, 1x1rib, interlock, single pique and fleece knitted fabrics has been improved due to the presence of 5% Elastane in 95% cotton yarns. This is due to the fibers in the yarn are held by Elastane yarn in addition to the twist inserted to the cotton yarn.

The descending order of abrasion resistance of the five knitted fabrics made from 100%cotton and cotton/Elastane yarns is single jersey, single pique, 1x1rib and interlock and fleece knitted fabrics. In Table 4, the mean, standard deviation, standard error, minimum and maximum values of test specimens are shown. The standard deviations of single jersey and single pique (0.22361) are the same in 100%cotton and cotton/Elastane yarns; 1x1rib and fleece knitted fabrics showed lower standard deviation with 5% Elastane in 95%cotton yarn than 100%cotton yarn; and interlock has a higher standard deviation with the same Elastane content in cotton than 100%cotton yarn. This is due to the values in a statistical data set shows different closeness to the mean of the data set, on average.

Table 4: Description for abrasion resistance of knitted fabrics made from 100%cotton and cotton/Elastane yarns

		N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Abrasion resistance of single jersey	95.00	5	2.9000	.22361	.10000	2.50	3.00
	100.00	5	2.1000	.22361	.10000	2.00	2.50
	Total	10	2.5000	.47140	.14907	2.00	3.00
Abrasion resistance of 1x1rib	95.00	5	2.5000	.00000	.00000	2.50	2.50
	100.00	5	1.8000	.27386	.12247	1.50	2.00
	Total	10	2.1500	.41164	.13017	1.50	2.50
Abrasion resistance of interlock	95.00	5	2.2000	.27386	.12247	2.00	2.50
	100.00	5	1.5000	.00000	.00000	1.50	1.50
	Total	10	1.8500	.41164	.13017	1.50	2.50
Abrasion resistance of single pique	95.00	5	2.6000	.22361	.10000	2.50	3.00
	100.00	5	1.9000	.22361	.10000	1.50	2.00
	Total	10	2.2500	.42492	.13437	1.50	3.00
Abrasion resistance of fleece	95.00	5	2.2000	.27386	.12247	2.00	2.50
	100.00	5	1.5000	.50000	.22361	1.00	2.00
	Total	10	1.8500	.52967	.16750	1.00	2.50

The abrasion resistance of single jersey, single pique, 1x1rib, interlock and fleece knitted fabrics mean differences are significant at 0.05 levels. As shown in Table 5, the abrasion resistance of single jersey is significantly influenced by the presence of 5% Elastane in the Upper Awash combed cotton yarn (F = 32.000; Sig. = 0.000478). 1x1Rib (F = 32.667; Sig. = 0.000446), interlock (F = 32.667; Sig. = 0.000446), single pique (F = 24.500; Sig. = 0.001000) and fleece (F = 7.538; Sig. = 0.025000) knitted fabrics are significantly influenced by the types of yarns (100%cotton and Cotton/Elastane-95/5%). 1x1Rib and interlock have greater F-Value as compared to other knitted fabrics which showed that 1x1rib and interlock have a high dispersion rate as compared to other knitted fabrics.

Table 5: Analysis of variance for abrasion resistance of knitted fabrics made from 100%cotton and cotton/Elastane yarns

		Sum of Squares	df	Mean Square	F	Sig.
Abrasion resistance of single jersey	Between Groups	1.600	1	1.600	32.000	.000478
	Within Groups	.400	8	.050		
	Total	2.000	9			
Abrasion resistance of 1x1rib	Between Groups	1.225	1	1.225	32.667	.000446
	Within Groups	.300	8	.038		
	Total	1.525	9			
Abrasion resistance of interlock	Between Groups	1.225	1	1.225	32.667	.000446
	Within Groups	.300	8	.038		
	Total	1.525	9			
Abrasion resistance of single pique	Between Groups	1.225	1	1.225	24.500	.001
	Within Groups	.400	8	.050		

	Total	1.625	9			
Abrasion resistance of fleece	Between Groups	1.225	1	1.225	7.538	.025
	Within Groups	1.300	8	.163		
	Total	2.525	9			

3.2. Pilling Resistance of Knitted Fabrics

Pilling resistance of single jersey, 1x1rib, interlock, single pique and fleece knitted fabrics were studied and the results are shown in Table 6. The pilling resistance of single jersey, 1×1rib, interlock, single pique and fleece knitted fabrics made from 100% cotton and cotton/Elastane (95/5%) blended yarns is different. The pilling resistances of single jersey, single pique and fleece knitted fabrics made from 100%cotton are lower as compared to the same fabrics made from cotton/Elastane blended yarn while 1x1rib and interlock knitted fabrics made from cotton/Elastane yarn has the lowest pilling resistance as compared to the same fabrics made from 100%cotton yarn. This is because 1x1rib and interlock knitted fabrics have greater widthwise shrinkage which leads to higher exposure of fibers for protruding and pilling on the fabrics. The pilling resistance of interlock knitted fabric made from 100%cotton has an excellent pilling resistance than the other knitted fabrics made from the same materials while single jersey made from cotton/Elastane has higher pilling resistance than the other knitted fabrics made from the same materials. This is because single jersey knitted fabric is irreversible or single faced fabric and exposed to friction (abrasion) in its technical face loops. But, all the technical back loops are hidden and results in excellent pilling resistance. The technical face loops are smooth, and the loop parts such as loop arm (stem) is visible and subjected for friction to form balls while head and feet of loop are hidden. The technical face loops are resistant to pilling and the fabric appearance and service will be better with face loops than back loops. Interlock and 1x1rib knitted fabrics made from cotton/Elastane yarn have the lowest bursting strength as compared to other knitted fabrics because the interlock and 1x1rib knitted fabrics have greater shrinkage and results in loosed and protrude fibers. These loosed cotton fibers are easily pilled by slight frictions on the surface of the fabrics. 1x1Rib knitted fabric made from cotton/Elastane yarns as the lowest pilling resistance due to two reasons. Firstly, in 1x1rib the fabric is composed of face and reverse meshed stitches across the width of the fabric and results in vertical corrugation with vertical cord appearance due to the face and reverse meshed loops are found on the same side of the fabrics. Secondly, 1x1rib knitted fabric has higher widthwise shrinkage which results in high relaxation and leads to loosed tension between fibers in the yarn. By these reasons 1x1rib knitted fabric losses its resistance to pilling which in turn affects the appearance and comfort of knitted fabrics. The pilling resistance of single jersey, single pique and fleece knitted fabrics has been improved due to the presence of 5%Elastane in 95% cotton yarn. This is because the fibers in the yarn are held (covered) by Elastane yarn in addition to the twist inserted to the cotton yarn.

In Table 6, the mean, standard deviation, standard error, minimum and maximum values of the test specimens are shown. The single jersey has higher standard deviations with cotton/Elastane than with 100%cotton yarns while 1x1rib, single pique and fleece knitted fabrics have higher standard deviations with 100%cotton yarn than with cotton/Elastane yarn; and interlock knitted fabric has the same standard deviations in both 100%cotton and cotton/Elastane yarns. This is due to the values in a statistical data set shows different closeness to the mean of the data set, on average.

Table 6: Description for bursting strength of knitted fabrics made from 100%cotton and cotton/Elastane (95/5%)

		N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Pilling resistance of single jersey	95.00	5	4.4800	.16432	.07348	4.30	4.70
	100.00	5	2.5400	.11402	.05099	2.40	2.70
	Total	10	3.5100	1.03113	.32607	2.40	4.70
Pilling resistance of 1x1rib	95.00	5	1.5000	.00000	.00000	1.50	1.50
	100.00	5	2.4000	.15811	.07071	2.20	2.60
	Total	10	1.9500	.48591	.15366	1.50	2.60
Pilling resistance of interlock	95.00	5	2.3000	.27386	.12247	2.00	2.50
	100.00	5	4.2000	.27386	.12247	4.00	4.50
	Total	10	3.2500	1.03414	.32702	2.00	4.50
Pilling resistance of single pique	95.00	5	3.8000	.44721	.20000	3.50	4.50
	100.00	5	2.9000	.54772	.24495	2.50	3.50
	Total	10	3.3500	.66875	.21148	2.50	4.50
Pilling resistance of fleece	95.00	5	4.4000	.22361	.10000	4.00	4.50
	100.00	5	2.1000	.54772	.24495	1.50	2.50
	Total	10	3.2500	1.27475	.40311	1.50	4.50

The pilling resistance of single jersey, single pique, 1x1rib, interlock and fleece knitted fabrics mean differences are significant at 0.05 levels. As shown in Table 7, the pilling resistance of single jersey is significantly influenced by the presence of 5% Elastane in the Upper Awash combed cotton yarn (F = 470.450; Sig. = 0.000000). 1x1Rib (F = 162.000; Sig. = 0.000001), interlock (F = 120.333; Sig. = 0.000004), single pique (F = 8.100; Sig. = 0.022000) and fleece (F = 75.571; Sig. = 0.000024) knitted fabrics are significantly influenced by the types of yarns (100%cotton and Cotton/Elastane-95/5%). Single jersey has a higher F-Value as compared to other knitted fabrics which showed that single jersey has a high dispersion rate as compared to other knitted fabrics.

Table 7: Analysis of variance knitted fabrics made from 100%cotton and Cotton/Elastane yarns

		Sum of Squares	df	Mean Square	F	Sig.
Pilling resistance of single jersey	Between Groups	9.409	1	9.409	470.450	.000000
	Within Groups	.160	8	.020		
	Total	9.569	9			
Pilling resistance of 1x1rib	Between Groups	2.025	1	2.025	162.000	.000001
	Within Groups	.100	8	.013		
	Total	2.125	9			
Pilling resistance of interlock	Between Groups	9.025	1	9.025	120.333	.000004
	Within Groups	.600	8	.075		
	Total	9.625	9			

Pilling resistance of single pique	Between Groups	2.025	1	2.025	8.100	.022000
	Within Groups	2.000	8	.250		
	Total	4.025	9			
Pilling resistance of fleece	Between Groups	13.225	1	13.225	75.571	.000024
	Within Groups	1.400	8	.175		
	Total	14.625	9			

4. CONCLUSION

The performance characteristics of five weft knitted structures made from 100% cotton and 95% cotton /5% Elastane blended yarns were studied. As investigated in the results and discussion, the bursting strength of knitted fabric made from cotton/Elastane yarn has been reduced for an Elastane is feed to the needles as naked filament (generally not skin friendly with cotton yarn). The fabric thickness and shrinkage was significantly increased in knitted fabrics made from cotton/Elastane yarns as compared to the same fabrics made from 100%cotton. The bursting strength of 1×1rib knitted fabric is better as compared to interlock and single jersey knitted fabrics in both 100% cotton and cotton/Elastane blended yarns due to the high widthwise extensibility of 1x1rib knitted fabric. Interlock has the lowest bursting strength since interlock is made by locking two 1x1rib knitted fabrics internally and its extensibility is reduced (limited).

An abrasion resistance of knitted fabric improved with cotton/Elastane yarns as compared to 100%cotton yarns. This is because an Elastane yarn has been given to needles with cotton yarn as naked filament and increases the thickness of the fabrics that improves an abrading resistance of knitted fabrics. An abrasion resistance of single jersey knitted fabric made from 100%cotton and cotton/Elastane is highest as compared to the other knitted fabrics made from the same yarns. This is due to single jersey knitted fabric is exposed to friction (abrasion) in its technical face loops but all technical back loops are hidden. The technical face loops are smooth and the loop parts such as loop arm (stem) is visible and subjected for abrasion while head and feet of loop are hidden. The technical face loops are resistant to abrasion and the fabric appearance and service will be better with face loops than back loops. Single jersey made from cotton/Elastane has the highest pilling resistance as compared to the other knitted fabrics made from the same materials. This is because single jersey knitted fabric is irreversible or single faced fabric and exposed to friction (abrasion) in its technical face loops, but all the technical back loops are hidden and results in excellent pilling resistance. The technical face loops are smooth and the loop parts such as loop arm (stem) is visible and subjected for friction to form balls while head and feet of loop are hidden. The technical face loops (single jersey, single pique and fleece) are resistant to pilling and the fabric appearance and service will be better with face loops than back loops (1x1rib and interlock).

Generally, Elastane yarn has significant influence on performance characteristics of knitted fabrics. So, knitting technologists have to consider the performance characteristics such as bursting strength, abrasion and pilling resistance of knitted fabrics in addition to improving an extensibility of the knitted fabrics.

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