Research Article

Tensile Properties of Single Jersey and 1×1 Rib Knitted Fabrics Made from 100% Cotton and Cotton/Lycra Yarns

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The tensile properties such as tensile strength which is measured as breaking force in Newton (N) and elongation percent (%) at break of single jersey and 1×1 rib (knitted with full needles) knitted fabrics made from 100% cotton and cotton/Lycra yarns (5% Lycra yarn content in 95% combed cotton yarn) are investigated in this research. The sample fabrics are conditioned for 24 hours at 20±1°C temperature and 65±2% relative humidity before testing. Ten specimens (five for lengthwise and five for widthwise) have been taken from each of the two knitted structures, those made from 100% cotton and cotton/Lycra (at 95/5 percent ratio blend) yarns. According to the discussion and as found from the investigations, the tensile properties of single jersey and 1×1 rib knitted fabrics made from 100% cotton and cotton/Lycra yarns are significantly different from each other and both of the knitted fabrics have high elongation percent at break with cotton/Lycra blend yarns as compared to 100% cotton yarn. Knitted fabrics made from cotton/Lycra blended yarns have low breaking force and high elongation percent at break relative to knitted fabrics made from 100% cotton yarns.

1. Introduction

Knitted fabrics are produced by intermeshing the yarns which can be made from natural, synthetic, or regenerated fibers. The raw material types and structures give different properties for the yarns used in knitting. The variation in yarn properties results in variation of knitted fabrics properties such as dimensional, mechanical, comfort, and appearance. Mechanical properties, particularly strength and elongation, are the most important performance properties of knitted fabrics which governs the fabric performance in use by causing a change in dimensions of strained knitted fabrics [1–3]. A change of dimensions of strained knitted fabric can be defined by increasing dimension in one direction as dimension in other directions is decreasing [4, 5]. In many cases, it is important to know how much the knit will deform in one or another direction. On the other hand it is known that, in various knitting structures, knitted fabrics are characterized in different extensibility (in a course and wale directions) and maximum force to rupture [6, 7]. Processes of deformation of knitted fabrics are described in concept of extensibility of knitted fabric and the deformation can be determined and influenced by different factors.

References [5, 8, 9] investigated the effect of knit structure and raw materials on plated knitted fabrics tensile properties and the results showed that the tensile strength and elongation at break of plated single jersey, plated rib 4:2, and plated purl knitted fabrics are different due to the variations in physical and chemical properties of cotton, silk, polyester, polyamide, viscose, bamboo, and their blends at different ratio and count. References [10, 11] reported that the mechanical property of knitted fabrics is the matter of yarn, fabric structure, and the knitting process and found that tensile property of jacquard weft knitted fabrics is different in birds eye, striped jacquard, and twill jacquard knit structures.

References [12, 13] experimentally investigated the parameters of colored double jacquard fabrics as the coefficient of stitch density, the stitch length, the surface density, and the extensibility of fabric. It has been established that extensibility
Table 1: Fiber properties.

<table>
<thead>
<tr>
<th>Properties</th>
<th>Type of fiber</th>
<th>Origin</th>
<th>Staple length</th>
<th>Short fiber index</th>
<th>Nep</th>
<th>Trash</th>
<th>Micronaire</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cotton (100%)</td>
<td>Upper Awash</td>
<td>28 mm</td>
<td>12.8</td>
<td>300</td>
<td>4.06</td>
<td>4.2</td>
</tr>
</tbody>
</table>

Table 2: Yarn specifications.

<table>
<thead>
<tr>
<th>Machine type</th>
<th>Twist (l/m)</th>
<th>Ne</th>
<th>U%</th>
<th>CVM</th>
<th>Thin+50%</th>
<th>Thick+50%</th>
<th>Nep+200%</th>
<th>TIP</th>
<th>Lyca count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ring frame</td>
<td>750</td>
<td>28</td>
<td>9.21</td>
<td>11.70</td>
<td>0</td>
<td>33.6</td>
<td>29.8</td>
<td>63.4</td>
<td>40 denier</td>
</tr>
</tbody>
</table>

Table 3: Fabric specifications.

<table>
<thead>
<tr>
<th>Machine type</th>
<th>Machine number</th>
<th>Speed (rpm)</th>
<th>Adjusted loop length (mm)</th>
<th>Machine diameter (inch)</th>
<th>Number of needles</th>
<th>Gauge</th>
<th>Number of feeders</th>
<th>Number of cam tracks</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEYER &amp; CIE</td>
<td>60</td>
<td>30</td>
<td>3.21</td>
<td>34</td>
<td>2976</td>
<td>28</td>
<td>108</td>
<td>4</td>
<td>Circular for single jersey</td>
</tr>
<tr>
<td></td>
<td>99</td>
<td>20</td>
<td>3.25</td>
<td>30</td>
<td>1404</td>
<td>18</td>
<td>62</td>
<td>1</td>
<td>Circular for 1×1 rib</td>
</tr>
</tbody>
</table>

Table 4: Equipment and materials used.

<table>
<thead>
<tr>
<th>S/r number</th>
<th>Name of equipment</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>Uster tester-5</td>
<td>U%, CVM, Thin, Thick, Nep</td>
</tr>
<tr>
<td>(2)</td>
<td>Round sample cutter</td>
<td>Sample fabric</td>
</tr>
<tr>
<td>(3)</td>
<td>MESDAN TENSO Tensile tester</td>
<td>Breaking force (N) and elongation (%)</td>
</tr>
</tbody>
</table>

2. Materials and Methods

2.1. Materials. Cotton/Lycra blend and 100% cotton yarns are used for this study. The Lycra accounts for about 5% content (40 denier = 133 Ne) while cotton accounts for 95% content (35 Ne) in the resultant 28 Ne combed cotton/Lycra blended yarn (cotton/Lycra = 95/5%) and the Lycra is plied with the cotton yarn. Tensile properties of single jersey and 1×1 rib knitted fabrics made from 100% cotton and cotton/Lycra blend (95/5 in percentage) by conducting scientific tests and analysis.

Yarn specifications (see Table 2), knitting machine settings, and fabric parameters (see Table 3) are controlled constantly throughout the study.

2.2. Experiments. Single jersey and 1×1 rib knitted fabrics are the raw materials (fabrics) for this study. These fabrics are produced on circular knitting machines with the machine parameters and fabric specifications shown in Table 3. Tests for yarn and knitted fabrics properties are performed using the equipment shown in Table 4.

3. Results and Discussion

3.1. Results. Tensile properties of single jersey and 1×1 rib knitted fabrics made from 100% cotton and cotton/Lycra blended yarns are studied by performing proper laboratory tests. The experiments are done as directed in ASTM D5035-95, termed as Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method) using MESDAN TENSO Tensile tester at 300 mm/min clamp speed, 75 mm gauge length (sample length), 5 kN load cell, and 0 N pretension [14, 15]. The results are recorded as per this standard and shown in Table 5 (for single jersey) and Table 6 (for 1×1 rib).

3.2. Discussion. Tensile properties such as tensile strength and elongation percent at break of single jersey and 1×1 rib knitted fabrics made from 100% cotton and cotton/Lycra (95/5%) blended yarns test results are recorded in Tables 5 and 6. The tensile strength is measured by the amount of maximum force required to break the fabrics in Newton while the elongation is the fabrics extension percent (%) until the fabric is broken.

The tensile strength of single jersey made from 100% cotton has the maximum breaking force between 211 N and 235 N with an average 220.8 N along the length of the fabric and between 149 N and 166 N with an average of 159 N.
Table 5: Tensile properties of single jersey knitted fabrics.

<table>
<thead>
<tr>
<th>Knitted fabrics made from</th>
<th>Test direction</th>
<th>Tensile properties</th>
<th>Specimens</th>
<th>Specimens</th>
<th>Specimens</th>
<th>Specimens</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Max. breaking force in N</td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>100% cotton</td>
<td>Lengthwise</td>
<td>217</td>
<td>215</td>
<td>235</td>
<td>211</td>
<td>226</td>
</tr>
<tr>
<td></td>
<td>Widthwise</td>
<td>130.8</td>
<td>116</td>
<td>112.4</td>
<td>119.2</td>
<td>117.2</td>
</tr>
<tr>
<td>Cotton/Lycra</td>
<td>Lengthwise</td>
<td>127</td>
<td>130</td>
<td>127</td>
<td>123</td>
<td>132</td>
</tr>
<tr>
<td></td>
<td>Widthwise</td>
<td>178</td>
<td>181</td>
<td>189</td>
<td>181</td>
<td>190</td>
</tr>
</tbody>
</table>

Table 6: Tensile properties of 1×1 rib knitted fabrics.

<table>
<thead>
<tr>
<th>Knitted fabrics made from</th>
<th>Test direction</th>
<th>Tensile properties</th>
<th>Specimens</th>
<th>Specimens</th>
<th>Specimens</th>
<th>Specimens</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Max. breaking force in N</td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>100% cotton</td>
<td>Lengthwise</td>
<td>345</td>
<td>337</td>
<td>346</td>
<td>317</td>
<td>280</td>
</tr>
<tr>
<td></td>
<td>Widthwise</td>
<td>57.2</td>
<td>50</td>
<td>55</td>
<td>51.2</td>
<td>45.6</td>
</tr>
<tr>
<td>Cotton/Lycra</td>
<td>Lengthwise</td>
<td>278</td>
<td>277</td>
<td>281</td>
<td>276</td>
<td>269</td>
</tr>
<tr>
<td></td>
<td>Widthwise</td>
<td>88</td>
<td>75</td>
<td>79</td>
<td>71</td>
<td>83</td>
</tr>
</tbody>
</table>

Table 7: Description for tensile strength of single jersey and 1×1 rib knitted fabrics made from 100% cotton and cotton/Lycra (95/5%).

<table>
<thead>
<tr>
<th>N</th>
<th>Mean</th>
<th>Std. deviation</th>
<th>Std. error</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>95.00</td>
<td>5</td>
<td>127.8000</td>
<td>3.42053</td>
<td>1.52971</td>
<td>123.00</td>
</tr>
<tr>
<td>100.00</td>
<td>5</td>
<td>220.8000</td>
<td>9.65401</td>
<td>4.31741</td>
<td>211.00</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td>174.3000</td>
<td>49.48861</td>
<td>15.64967</td>
<td>123.00</td>
</tr>
<tr>
<td>95.00</td>
<td>5</td>
<td>183.8000</td>
<td>5.35724</td>
<td>2.39583</td>
<td>178.00</td>
</tr>
<tr>
<td>100.00</td>
<td>5</td>
<td>159.0000</td>
<td>6.32456</td>
<td>2.82843</td>
<td>149.00</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td>171.4000</td>
<td>14.19076</td>
<td>4.48751</td>
<td>149.00</td>
</tr>
<tr>
<td>95.00</td>
<td>5</td>
<td>276.2000</td>
<td>4.43847</td>
<td>1.98494</td>
<td>269.00</td>
</tr>
<tr>
<td>100.00</td>
<td>5</td>
<td>335.2000</td>
<td>11.88276</td>
<td>5.31413</td>
<td>317.00</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td>305.7000</td>
<td>32.22508</td>
<td>10.19046</td>
<td>269.00</td>
</tr>
</tbody>
</table>

across the width of the fabric. The single jersey made from cotton/Lycra blended yarn has the maximum breaking force between 123 N and 132 N with an average of 127.8 N along the length and between 178 N and 190 N with an average of 183.8 N across the width of knitted fabric (see Tables 5 and 7). The tensile strength of 1×1 rib knitted fabric made from 100% cotton has maximum breaking force between 317 N and 346 N with an average of 335.2 N along the length of the fabric and between 90 N and 110 N with an average of 98.2 N across the width of the fabric. The 1×1 rib knitted fabric made from cotton/Lycra blend has the maximum breaking force between 269 N and 281 N with an average of 276.2 N along the length and between 71 N and 88 N with an average of 79.2 N across the width of the fabric (see Tables 6 and 7).
Table 8: Description for elongation (%) of single jersey and 1×1 rib knitted fabrics made from 100% cotton and cotton/Lycra (95/5%).

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. deviation</th>
<th>Std. error</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single jersey lengthwise elongation (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>95.00</td>
<td>5</td>
<td>219.4800</td>
<td>5.90186</td>
<td>2.63939</td>
<td>213.00</td>
<td>228.00</td>
</tr>
<tr>
<td>100.00</td>
<td>5</td>
<td>119.1200</td>
<td>6.98226</td>
<td>3.12256</td>
<td>112.40</td>
<td>130.80</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td>169.3000</td>
<td>53.24436</td>
<td>16.83735</td>
<td>112.40</td>
<td>228.00</td>
</tr>
<tr>
<td>Single jersey widthwise elongation (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>95.00</td>
<td>5</td>
<td>198.2800</td>
<td>6.72250</td>
<td>3.00639</td>
<td>193.00</td>
<td>208.40</td>
</tr>
<tr>
<td>100.00</td>
<td>5</td>
<td>135.2400</td>
<td>3.88947</td>
<td>1.73943</td>
<td>131.20</td>
<td>139.40</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td>166.7600</td>
<td>33.62602</td>
<td>10.63348</td>
<td>131.20</td>
<td>208.40</td>
</tr>
<tr>
<td>1×1 rib lengthwise elongation (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>95.00</td>
<td>5</td>
<td>121.0000</td>
<td>5.69210</td>
<td>2.54558</td>
<td>113.20</td>
<td>128.40</td>
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<tr>
<td>100.00</td>
<td>5</td>
<td>51.8000</td>
<td>4.51221</td>
<td>2.01792</td>
<td>45.60</td>
<td>57.20</td>
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<td>Total</td>
<td>10</td>
<td>86.4000</td>
<td>36.79167</td>
<td>11.63455</td>
<td>45.60</td>
<td>128.40</td>
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<tr>
<td>1×1 rib widthwise elongation (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>95.00</td>
<td>5</td>
<td>617.8000</td>
<td>29.34553</td>
<td>13.12372</td>
<td>588.40</td>
<td>658.80</td>
</tr>
<tr>
<td>100.00</td>
<td>5</td>
<td>314.3600</td>
<td>10.24734</td>
<td>4.58275</td>
<td>303.40</td>
<td>328.80</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td>466.0800</td>
<td>161.26385</td>
<td>50.99611</td>
<td>303.40</td>
<td>658.80</td>
</tr>
</tbody>
</table>

The elongation percentage at break for the single jersey knitted fabric made from 100% cotton is found between 112.4% and 130.8% with an average 119.12% along the length of the fabric and between 131.2% and 139.4% with an average of 135.24% across the width of the fabric. The single jersey made from cotton/Lycra blended has the elongation percent at break between 213% and 228% with an average of 219.48% along the length and between 193% and 208.4% with an average of 198.28% across the width of fabric (see Tables 5 and 8). The elongation at break of 1×1 rib knitted fabric made from 100% cotton has between 45.6% and 57.2% with an average 51.8% along the length of the fabric and between 303.4% and 328.8% with an average of 314.36% across the width of the fabric. The 1×1 rib knitted fabric made from cotton/Lycra blended has the elongation at break (%) between 113.2% and 128.4% with an average of 121% along the length and between 588.4% and 658.8% with an average of 617.8% across the width of the fabric (see Tables 6 and 8).

As shown in Table 7 and Figure 1, the maximum force in Newton required to break the fabrics is different. Single
jersey and 1×1 rib knitted fabrics made from 100% cotton have high breaking force as compared to fabrics made from cotton/Lycra blended yarns. After adding the Lycra yarn, the maximum breaking force in the lengthwise of the single jersey decreased as compared to its widthwise breaking force because of the high elongation percent in the lengthwise direction of the fabric. Single jersey knitted fabric has high extension characteristic in the lengthwise than its widthwise direction. Fabrics with high extension property needs low force to extend and its strength become decreased. Length-wise breaking strength of 1×1 rib knitted fabrics is higher than single jersey’s both lengthwise and widthwise breaking strength. But, the widthwise strength of 1×1 rib is lower than the single jersey's lengthwise and widthwise strengths (see Table 7 and Figure 1).

When the breaking force (strength) of the single jersey and 1×1 rib knitted fabrics increases the elongation percent at break decreased. In this research it is found that tensile strength and elongation percent at break are inversely proportional (see Tables 7 and 8, Figures 1 and 2). The elongation at break of single jersey and 1×1 rib knitted fabrics made from 100% cotton is lower than the elongation of these fabrics made from cotton/Lycra (at 95/5% ratio) blended yarns.

The elongation percent of single jersey and 1×1 rib knitted fabrics increased both in the lengthwise and widthwise with the presence of 5% Lycra yarns in the fabric. But the elongation percent at break of 1×1 rib knitted fabric made from cotton/Lycra blended yarn is higher than single jersey in both the lengthwise and widthwise directions (see Table 8 and Figure 2). The widthwise elongation percent at break of 1×1 rib knitted fabric is higher than its lengthwise elongation percent due to the higher widthwise extension characteristic of 1×1 rib knitted fabrics. It is known that rib knitted fabrics have high widthwise extension characteristic due to the high widthwise shrinkage property (see Table 11) of rib knitted fabrics.

The tensile strength of single jersey and 1×1 rib knitted fabrics made from 100% cotton and cotton/Lycra blended yarns is significantly different one from the other. The length-wise and widthwise tensile strength of single jersey knitted fabric are significantly influenced by the Lycra yarns at \( F = 412.250 \), Sig. = 0.000 and \( F = 44.730 \), Sig. = 0.000, respectively (see Table 9). The \( F \)-value in the lengthwise direction is much higher than the widthwise direction because of the high tensile strength (breaking force in Newton) reduction in the presence of 5% Lycra in 95% combed cotton yarn along the length of single jersey knitted fabrics (see Table 7).

The lengthwise and widthwise tensile strength of 1×1 rib knitted fabric is significantly influenced by the Lycra yarns at \( F = 108.173 \), Sig. = 0.000 and \( F = 17.207 \), Sig. = 0.000, respectively (see Table 9).

The breaking elongation percent (%) of single jersey and 1×1 rib knitted fabrics made from 100% cotton and cotton/Lycra blended yarns is significantly different one from the other. The lengthwise and widthwise breaking elongation of single jersey knitted fabric is significantly influenced by the Lycra yarns at \( F = 602.515 \), Sig. = 0.000 and \( F = 329.412 \), Sig. = 0.000, respectively (see Table 10). The \( F \)-value in the lengthwise direction is much higher than in the widthwise direction because of the high elongation percent difference between 100% cotton and cotton/Lycra (95% cotton) along the length of knitted fabrics.
Table 9: Analysis of variance for tensile strength of single jersey and 1×1 rib knitted fabrics made from 100% cotton and cotton/Lycra (95/5%).

<table>
<thead>
<tr>
<th></th>
<th>Sum of squares</th>
<th>df</th>
<th>Mean square</th>
<th>$F$</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single jersey lengthwise tensile strength</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between groups</td>
<td>21622.500</td>
<td>1</td>
<td>21622.500</td>
<td>412.250</td>
<td>.000</td>
</tr>
<tr>
<td>Within groups</td>
<td>419.600</td>
<td>8</td>
<td>52.450</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>22042.100</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single jersey widthwise tensile strength</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between groups</td>
<td>1537.600</td>
<td>1</td>
<td>1537.600</td>
<td>44.763</td>
<td>.000</td>
</tr>
<tr>
<td>Within groups</td>
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<td>34.350</td>
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<td></td>
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<td>Total</td>
<td>1812.400</td>
<td>9</td>
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<td></td>
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<td>1×1 rib lengthwise tensile strength</td>
<td></td>
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<tr>
<td>Between groups</td>
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<td>1</td>
<td>8702.500</td>
<td>108.173</td>
<td>.000</td>
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<td>Within groups</td>
<td>643.600</td>
<td>8</td>
<td>80.450</td>
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<tr>
<td>Total</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>1×1 rib widthwise tensile strength</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between groups</td>
<td>902.500</td>
<td>1</td>
<td>902.500</td>
<td>17.207</td>
<td>.003</td>
</tr>
<tr>
<td>Within groups</td>
<td>419.600</td>
<td>8</td>
<td>52.450</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1322.100</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 10: Analysis of variance for elongation (%) of single jersey and 1×1 rib knitted fabrics made from 100% cotton and cotton/Lycra (95/5%).

<table>
<thead>
<tr>
<th></th>
<th>Sum of squares</th>
<th>df</th>
<th>Mean square</th>
<th>$F$</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single jersey lengthwise elongation (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between groups</td>
<td>25180.324</td>
<td>1</td>
<td>25180.324</td>
<td>602.515</td>
<td>.000</td>
</tr>
<tr>
<td>Within groups</td>
<td>334.336</td>
<td>8</td>
<td>41.792</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>25514.660</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single jersey widthwise elongation (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between groups</td>
<td>9935.104</td>
<td>1</td>
<td>9935.104</td>
<td>329.413</td>
<td>.000</td>
</tr>
<tr>
<td>Within groups</td>
<td>241.280</td>
<td>8</td>
<td>30.160</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>10176.384</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1×1 rib lengthwise elongation (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between groups</td>
<td>11971.600</td>
<td>1</td>
<td>11971.600</td>
<td>453.813</td>
<td>.000</td>
</tr>
<tr>
<td>Within groups</td>
<td>211.040</td>
<td>8</td>
<td>26.380</td>
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<tr>
<td>Total</td>
<td>12182.640</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1×1 rib widthwise elongation (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between groups</td>
<td>230189.584</td>
<td>1</td>
<td>230189.584</td>
<td>476.500</td>
<td>.000</td>
</tr>
<tr>
<td>Within groups</td>
<td>3864.672</td>
<td>8</td>
<td>483.084</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>234054.256</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 11: Widthwise shrinkage of single jersey and 1×1 rib knitted fabrics.

<table>
<thead>
<tr>
<th>Type of fabric</th>
<th>Shrinkage in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single jersey from 100% cotton</td>
<td>20.9</td>
</tr>
<tr>
<td>Single jersey cotton/Lycra</td>
<td>33.19</td>
</tr>
<tr>
<td>1×1 rib from 100% cotton</td>
<td>28.88</td>
</tr>
<tr>
<td>1×1 rib from cotton/Lycra</td>
<td>48.72</td>
</tr>
</tbody>
</table>

4. Conclusion

The lengthwise and widthwise elongation percent of 1×1 rib knitted fabric are significantly influenced by the Lycra yarns at $F = 453.813$, Sig. = 0.000 and $F = 476.500$, Sig. 0.000, respectively (see Table 10). The $F$-value for the 1×1 rib across the widthwise is higher because of the higher difference between the elongation percent of 1×1 rib knitted fabric made from 100% cotton and cotton/Lycra (95% cotton) blended yarn. The widthwise elongation of 1×1 rib knitted fabrics increased as compared to its lengthwise elongation due to the presence of 5% Lycra in the 95% cotton yarn.

The tensile properties of single jersey and 1×1 rib knitted fabrics have been investigated in this research. The tensile strength which is measured as breaking force in Newton and elongation percent at break are the two tensile properties investigated in the lengthwise and widthwise direction of the single jersey and 1×1 rib knitted fabrics made from 100% cotton and cotton/Lycra blended yarns. The ratio of cotton to
Lycra was 95% to 5%, respectively, and the presence of Lycra yarn in the combed cotton yarn significantly influences both the lengthwise and widthwise tensile strength and elongation percent of the two knitted fabrics. The single jersey’s tensile strength reduced with the cotton/Lycra yarn along the length while its tensile strength is slightly increased across the width as compared to 100% cotton yarn. The elongation percent of single jersey increased more in the lengthwise than in the widthwise with the presence of 5% Lycra in 95% cotton yarn as compared to 100% cotton yarn. The 1×1 rib knitted fabric’s tensile strength and elongation percent at break in the lengthwise and widthwise directions of the fabric increased with the cotton/Lycra blended yarn as compared to 100% cotton yarn. It is found that Lycra yarn may not improve the tensile properties of all types of knitted structures. Though the type of yarns used in these two fabrics significantly influences the strength and elongation, the type of structure has its own influence in order to withstand the applied force in the lengthwise and widthwise directions of the fabrics. The 1×1 rib knitted caused the big difference between lengthwise and widthwise in maximum breaking force or elongation at break due to the greater extension characteristic across the width of the rib knitted fabrics. Single jersey knitted fabrics are single sided fabrics and produced on one set of needles [16]. This leads single jersey to have low shrinkage and high curling tendency. The shrinkage is more with rib knitted fabrics across its widthwise directions than its lengthwise and single jersey.

During the investigation we found that tensile strength which is measured as a maximum braking force in Newton and elongation percent (%) at the break are inversely proportional. Higher breaking force is consumed for low elongation percent at the break and the reverse is also true. Knitted fabrics made from cotton/Lycra blended yarn have low breaking force and high elongation percent at break relative to knitted fabrics made from 100% cotton yarns.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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