Effect of wrinkle resistance finish on cotton fabric properties

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The effect of crease resistant finish on wrinkle recovery, breaking strength, tearing strength and pilling performance of 100 % cotton plain fabrics has been studied. Desizing, scouring and crease resistant finishing have been performed on the fabric and their effects are observed. A statistical analysis using a paired \( t \)-test with the significance level of \( \alpha = 0.05 \) has been performed to determine if a statistically significant difference exists among fabric properties using the above processes. It is observed that no statistically significant change occurs on the fabric properties from scouring. However, the changes due to crease resistant finish are found to be statistically significant. In addition, the wrinkle recovery angle increases approximately 50%, and breaking strength and tear strength decrease about 25%, and pilling performance reduces 59% after the crease resistant finishing.

Keywords: Breaking strength, Crease resistant finish, Pilling performance, Tearing strength, Wrinkle recovery angle

One of the most important factors that influences the quality of fabric is the ability of fabrics to recover from induced wrinkles. Wrinkles are defined as the fabric deformations based on its viscoelastic properties. Wrinkles are classified into two categories, namely desirable wrinkles for smartness of clothes and undesirable wrinkles occurring during wear. Most research focuses on desirable wrinkles\textsuperscript{1}.

Fibre, yarn and fabric characteristics, and finish processes contribute to the development of wrinkles. Factors that affect wrinkle development include fibre type, bending performance of fibre, fibre diameter, yarn twist, weft-warp density, fabric construction, and fabric thickness. Some fibre types such as wool and cultivated silk have a good resistance to creasing, whereas cellulose materials such as cotton, viscose and linen have a very poor resistance to creasing\textsuperscript{2}. Improvement in fibre bending performance increases wrinkle resistances of fabrics. However, medium twist levels of yarn improve wrinkle resistances of fabrics. By increasing weft-warp density, wrinkle resistance of fabrics decreases. Knitted fabrics have a higher wrinkle resistance than woven fabrics. An increase in fabric thickness results in an increase in wrinkle resistance of fabrics. Many textile scientists have studied new methods to measure wrinkle resistance of fabrics\textsuperscript{3-8}. These new methods allow researchers to isolate the factors of wrinkle resistances of fabrics.

Many cotton fabrics are treated with chemicals to reduce wrinkling. This crease resistant finish to cotton fabrics improves comfort, ease of maintenance, dimensional stability and pilling performance. Additionally, chemically treated cotton fabrics dry more easily. However, the application of a crease resistant finish also shows unwanted effects on cotton fabrics. For example, breaking and abrasion strengths of fabrics decrease when crease resistant finishes are applied. To reduce unwanted effects caused by crease resistant finishes, several studies were performed on the effect of different chemical treatments and processing conditions on wrinkle resistance of fabrics\textsuperscript{9-12}. Many non-formaldehyde compounds have been used to impart crease resistant finish and it is found that the use of non-formaldehyde is inexpensive and hygienic\textsuperscript{13}.

Most apparel fabrics have a crease resistant finish applied to them, but this application increases the cost of the apparel and unwanted effects of reduced fabric breaking and tear strengths and pilling performance. The present study is aimed at investigating the relationship among different crease resistant finish and their effects on characteristics of plain cotton fabrics.

The 100 % cotton plain fabrics were used for the study. The yarns of the fabrics were spun at the carded spinning mill. The characteristics of weft and warp yarns are given in Table 1. The yarn measurements were carried out with an Uster Testex 3 and an Uster Tensorapid. The warping, sizing and weaving machine specifications are: Warping machine—machine mark: Benninger Ben-Direct 1000, machine model: 1997, creel capacity: 600; Sizing machine—machine mark: Benninger, machine

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model: 1986, maximum beam width: 220 cm; and
Weaving machine—machine mark: Toyoda Jat 600,
machine model: 1996, shedding mechanism: electronic
dobby, machine speed: 320 rpm, warp density: 20
ends/cm, weft density: 16 picks/cm.

Desizing, scouring and crease resistant finishing
were carried out using the recipe as given below:

(i) Desizing process: 1.0 g/L enzyme, 2.0 g/L non-
ionic wetting agent, 2.0 g/L salt, and 0.3 g/L CaCl_2
were used for desizing. The fabric was passed
through a foulard at 70°C for 4 h and then washed in warm water.

(ii) Scouring: The fabric was treated with
NaOH (5%) at 95°C for 2 h by
pad-roll method.

(iii) Crease resistant finish: 100 g/L crease resistant finish
(glyoxal reactive), 10 g/L MgCl_2
and 1 g/L CH_3COOH were
applied by impregnation method.
It was dried at 110°C, and then
condensation was done at 140°C
for 2 min.

Wrinkle resistance angle, breaking strength, tear
strength and pilling were measured after every applied
finish process as per the standards, ISO 2313, ISO
13934 -1, ISO 13937-1 and ISO 12945-2 respectively.
The finished fabrics were classified according to
the types of applied finish processes, such as Group 1
(desizing), Group 2 (desizing + scouring) and Group 3
(desizing + scouring + crease resistant finish). Table 2
shows the fabric characteristics for Groups 1-3
fabrics.

A paired t-test (significance level α=0.05)
statistical analysis on the arithmetic mean of fabric
characteristics has been performed to determine if
these differences between groups are statistically
significant. No statistically significant differences are
observed between the first group fabric characteristics
and the second group fabric characteristics. However,
statistically significant differences are found to occur
between the second group fabric characteristics and
the third group fabric characteristics. Specifically, it is
found that the scouring process does not measurably
change the fabric characteristics. In contrast, the
crease resistant finish significantly and measurably
changes the fabric characteristics.

Wrinkle Recovery Angle
Wrinkle recovery angle is increased by crease
resistant finish. The warp and weft wrinkle recovery angles of Groups 1-3 fabrics are shown in Table 2. On
comparing wrinkle recovery angles of Groups 2 and 3
fabrics, it is observed that the Group 3 fabrics show
46% increase in wrinkle recovery angle in warp
direction and 61% increase in weft direction over
Group 2.

Breaking Strength
The crease resistant finishes also limit the
movement of fibre elements. However, limiting fibre
movement will reduce the breaking strength of fibre.
Fibres with crease resistant finishes are more
susceptible to exceeding the fibre breaking strength
under an applied force. Table 2 shows that the
breaking strength of Group 3 fabrics is lower than the
breaking strength of Groups 1 and 2 fabrics. It is
found that the decrease in breaking strength of Group
3 fabrics as compared to Groups 1 and 2 fabrics is
28% in warp direction and 27% in weft direction.

Tearing Strength
Crease resistant finish causes a decrease in tear
strength. Table 2 shows a decrease in tear strength of
Group 3 fabrics as compared to Groups 1 and 2
fabrics. It is found that tear strength of Group 3
fabrics is 18% in warp direction and 20% in weft
direction to those of Groups 1 and 2 fabrics.

Pilling
Crease resistant finishes also affect pilling
performance of woven fabrics by decreasing the
ability of the fibre to move. Limiting fibre movement
leads to decreased pilling or improved pilling
performance. Table 2 shows that the pilling
performance of Group 3 fabrics increases over both
Groups 1 and 2 fabrics, the increase is 59% over
Group 2 fabrics.

The per cent changes of Group 3 fabric
characteristics in relation to Group 2 fabrics (plus sign
indicates increase and minus sign indicates decrease)
are: WRA= 46 % (+) (warp), 61% (+) (weft);
breaking load = 28 %(-)(warp), 27% (-) (weft);
tearing load = 18 % (-) (warp), 20% (-) (weft); and
pilling = 59% (-).

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<thead>
<tr>
<th>Property</th>
<th>Warp</th>
<th>Weft</th>
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<tbody>
<tr>
<td>Linear density, tex</td>
<td>29.42</td>
<td>29.67</td>
</tr>
<tr>
<td>Twist factor, α</td>
<td>4.7</td>
<td>3.6</td>
</tr>
<tr>
<td>Breaking tenacity , cN/tex</td>
<td>20.75</td>
<td>20.12</td>
</tr>
<tr>
<td>Evenness, %CV</td>
<td>12.95</td>
<td>13.77</td>
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<tr>
<td>Hairiness (H)</td>
<td>5.30</td>
<td>5.69</td>
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Table 2 — Properties of warp and weft yarns

Table 1 — Properties of warp and weft yarns

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Crease resistant finish improves wrinkle resistance of fabrics. However, the use of crease resistant finish produces undesired fabric characteristics such as decreased breaking strength, tear strength and pilling. With decreased pilling, fabric pilling performance improves. It is found that the crease resistant finish causes 50% increase in wrinkle recovery angle and pilling performance. On the other hand, the crease resistant finish causes 28% decrease in breaking strength and 19% decrease in tear strength.

In general, crease resistant finish applied to apparel fabric improves usage characteristics of clothes and leads to increased pilling performance of woven fabrics. Most researchers consider pilling performance as the most important factor of fabric wear characteristics. Limitations of applied crease resistant finishes to fabrics include reduced fabric breaking and tearing strength. However, the benefits of pilling performances from crease resistant finishes outweigh the drawbacks of reduced fabric breaking and tearing strength.

Usage of crease resistant finish can be based on two considerations, namely (i) the use of a crease resistant finish is commonly accepted if the pilling performance and wrinkle resistance of particular fabrics are preferred to limiting the breaking and tear strengths, and (ii) the use of a crease resistant finish is
unaccepted, if breaking and tear strengths of some fabrics are favoured over pilling performance. Warp and weft yarns with inherent strength characteristics offer an alternative to other fabrics that are susceptible to reduced breaking and tearing strengths when a crease resistant finish is applied. Reducing warp-weft fabric densities compensates for a decrease in tearing strength, but at the cost of reduced breaking strength and pilling performance.

It has been found that the finish processes significantly affect fibre characteristics. These findings infer that the types of usage and finish processes determine the wear characteristics of fabrics. Finish processes applied to the fabrics lead to increased fabric cost. Conclusively, the cost can be minimized by selecting fibre, yarn, and fabric with high wrinkle resistance characteristics before applying a crease resistant finish.

**Industrial Importance:** Anti-wrinkle finish operation is generally applied to fabrics for clothing. With the application of this operation, while wrinkle strength and pilling performance increase, the tensile and tearing strength of the fabric decrease. So, suitable determination of the application conditions of anti-wrinkle finish operation will be important in holding stated fabric properties in optimum.

**References**