INVESTIGATING THE EFFECTS OF DIFFERENT SOFTENERS ON PILLING PROPERTIES AND DURABILITY TO WASHING OF BAMBOO KNITTED FABRICS

BAMBU ÖRME KUMAŞLARDA FARKLI YUMUŞATICILARIN PILLİNG ÖZELLİKLERİ ve YIKAMA DAYANIKLİLİĞİ ÜZERİNE OLAN ETKİLERİİNİN İNCELENMESİ

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ABSTRACT

Fuzzing and pilling problems are one of the main problems of knitted fabrics. The softeners have various effects on pilling resistance of the fabrics. The aim of this study is to investigate systematically the effect of different softeners on pilling property of bamboo knitted fabrics. Furthermore, the washing durability of the used softeners after 5, 10 and 20 washing cycles was also examined. For this purpose, firstly 100% bamboo knitted fabrics were produced. After the fabrics were pre-treated and dyed, seven different softeners were applied to these fabrics by padding method. Then, all untreated and treated fabrics were laundered in Wascator. Washed cycles were being selected as 5, 10 and 20. In conclusion, it was found that the softeners generally decreased the pilling formation on bamboo knitted fabrics and the effect of softeners was positive. Among the softeners, before washing Softener S4 (cationic softener) and Softener S6 (mixture of carbamino derivative and micro silicone) were the best. The multiple washings caused increases in pilling formation due to the intensive mechanical effect during laundering on bamboo knitted fabrics.

Keywords: Bamboo, Softener, Pilling property, PillGrade

ÖZET


Anahtar Kelimeler: Bambu, Yumuşatıcı, Boncuklanma özelliği, PillGrade

1. INTRODUCTION

Bamboo fiber is obtained from the bamboo plant, which is an abundant and cheap natural resource. Bamboo, as a regenerated cellulosic fiber, is being more widely used in the textile industry due to its features such as being antibacterial, soft feeling, easy dyeability, proper moisture absorbency, breathability and having a smooth texture. This
fiber has wide prospects in the field of hygiene products, medical suppliers, such as wet wipe, household wipes, sanitary napkin, medical bandage, disposable sheet, inside lining, base cloth, nonwoven textiles, nano technological products. Furthermore, it is the 100% biodegradable textile material which does not cause any environmental pollution naturally recycling itself. In this sense, it is praised as the new environmentally friendly textile material (1-3).

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 using, pills form on the surface of the knitted fabric, remaining on the surface of the product and worsening its exterior. The development of pills on a fabric surface, in addition to spoiling the original appearance and hand, initiates garment attrition and reduces serviceability. Pilling is preceded by fuzz formation. Pilling is defined as the initiation garment attrition and reduces serviceability. Pilling is preceded by fuzz formation. Pilling is defined as the initiation garment attrition and reduces serviceability. Pilling is preceded by fuzz formation. Pilling is defined as the initiation garment attrition and reduces serviceability. Pilling is preceded by fuzz formation. Pilling is defined as the initiation garment attrition and reduces serviceability. Pilling is preceded by fuzz formation. 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PillGrade System

The PillGrade system is an automated pilling grading system developed to provide objective and repeatable pilling assessment in compliance with both ASTM and ISO test methods. It detects, measures, and grades pills by scanning the specimen’s horizon as the specimen is rolled over a rotating drive rod. By scanning the horizon of the fabric, the height of each pill can be measured, fuzzing can be measured, and fabric patterns and weave/knitted structure is disregarded. Figure 2 shows the fabric specimen rolling over the drive rod while the video camera captures the video images.

The fabric specimen runs through the rollers at a speed of about 1"/second (25 mm/sec). While the specimen runs through the rollers, the camera takes video of the fabric at a rate of 30 frames per second. So if the specimen is 4" (25 mm) in length, the camera will capture a total of 120 video frames of the specimen as it runs through the rollers.

Table 1. The codes and application recipes

<table>
<thead>
<tr>
<th>Code</th>
<th>Softener type</th>
<th>Recipes</th>
</tr>
</thead>
<tbody>
<tr>
<td>UT</td>
<td>Untreated fabric (only pre-treated and dyed fabric)</td>
<td>-</td>
</tr>
<tr>
<td>S1</td>
<td>Micro-dispersed poly-amino siloxane</td>
<td>30 g/l, pH: 5.5-6 (Acetic acid)</td>
</tr>
<tr>
<td>S2</td>
<td>Macro-emulsion of elastomeric poly-amino siloxane</td>
<td>30 g/l, pH: 4.5-5.5 (Acetic acid)</td>
</tr>
<tr>
<td>S3</td>
<td>Nano-emulsion of elastomeric polyamino siloxane</td>
<td>30 g/l, pH: 4.5-5 (Acetic acid)</td>
</tr>
<tr>
<td>S4</td>
<td>Cationic softener, Carbamide derivative</td>
<td>30 g/l, pH: 4-5 (Acetic acid)</td>
</tr>
<tr>
<td>S5</td>
<td>Nonionic softener, Polyethylene emulsion</td>
<td>30 g/l, pH: 6-7 (Acetic acid)</td>
</tr>
<tr>
<td>S6</td>
<td>Mixture of carbamino derivative and micro silicone</td>
<td>30 g/l, pH: 4.5-5 (Acetic acid)</td>
</tr>
<tr>
<td>S7</td>
<td>Mixture of carbamino derivative and macro silicone</td>
<td>30 g/l, pH: 4.5-5 (Acetic acid)</td>
</tr>
</tbody>
</table>

Impregnation conditions: Pick up value: 75%
Drying: 130°C for 3 min.

Figure 1. Martindale Pilling and Abrasion Tester (22)

Figure 2. Schematic view of the measuring principle of PillGrade system (23)
Every 1/30th of a second, the camera takes a single video frame. As shown above, two mirrors at different angles allow the camera to capture simultaneous images of both the horizon image and a slice of the fabric's top surface within each single video frame. By stitching together all of the video frames that are captured while the specimen runs through the rollers, a complete 3D topological map of the specimen is scanned into the PillGrade system.

After scanning the entire specimen, PillGrade analyzes each of the horizon images to detect and measure the pills, and then plots each pill’s XY location on the graph display using semi-circular markers color-coded by pill size, as shown in the figure below. Also, by stitching together each of the top surface images (as explained above), PillGrade also displays the surface scan of the specimen (Figure 3).

After scanning the specimen and detecting and measuring each and every pill in the center area of the specimen, PillGrade uses the PillGrade Grading system from 1.0 to 5.0 (1.0 means excessive pilling, 5.0 means no pilling).

The definitions of the results are given below:

**Pill Density:** Total number of pills in inspection area / total size of inspection area.

**Pill Count:** Total number of pills in inspection area.

**Pill Count, Weighted:** Using a logarithmic scale, each pill is mathematically weighted according to its size, where the largest pills (>Ø3.9mm) are multiplied by a factor of 5.0 and the smallest pills (<Ø0.3mm) are multiplied by a factor of 0.6.

**Fuzz Loft:** The height of the dense layer of fabric fuzz, disregarding the single strands of fuzz sticking up out of the denser layer of fuzz.

**Weighted Pill Density:** Total number of weighted pills in inspection area/total size of inspection area.

**Avg. Pill HC Diam:** (Average Pill Height-Compensated Diameter.) The average "size" of all the pills is in the inspection area. Because a pill is much more apparent if it rests higher up on a layer of fuzz, PillGrade uses a height-compensated pill diameter to measure the size of each pill (23).

All fabrics were assessed after Martindale pilling test. However, in order to determine the effect of washing and softeners, fabrics not tested in Martindale, were also assessed by using PillGrade instrument for their fuzz loft properties.

3. RESULTS AND DISCUSSION

**Evaluation of Pilling Degree**

Figure 4 illustrates the pilling degrees of untreated and treated bamboo fabrics.
Before washing, compared to the pilling degrees of all fabrics, the softened fabrics exhibited lower pilling tendency. Most of softeners gave high pilling values. It means that the effect of softeners is positive and they can prevent the pilling formation. As the softener type was evaluated on the unwashed fabrics, it can be said that softeners generally decreased the pilling formation. Especially, the pilling degree of fabric treated with softener S4 (cationic softener) was higher (lower pilling tendency) than that of other softeners. The reason of this result could be the changing of the fabric surface thanks to the cationic softener. The cationic softener gave to the fabric surface more slippery and softness.

The pilling degree did not decreased so much on the treated fabrics with softener S6 after washings. It means that softener S6 (Mixture of carbamino derivative and micro silicone) was durable to washing and prevented the pilling formation. It is thought that this is due to the synergistic effect of micro silicone and carbamino derivative.

While the number of washing cycles increased, the pilling formation except S6 rose as well. After 20 washings, the pilling formation was the maximum. It is thought that multiple washings caused increases in pilling formation due to the intense mechanical effect on bamboo knitted fabrics.

**Evaluation of Average Pill Height**

Figure 5 shows the average pill heights of untreated and treated bamboo fabrics.

Figure 5 shows that there are no significant differences between untreated and softened fabrics. The average pill height values (mm) of the fabrics were between 0.8 and 1.3 mm. After washing processes, average pill height values did not change significantly for all fabrics. As the softener type was evaluated, there are no important differences between softeners. While the number of washing cycles changed, there was no stable tendency on average pill height value.

**Evaluation of Weighted Pill Density**

Figure 6 demonstrates the weighted pill densities of untreated and treated bamboo fabrics.

![Graph showing average pill height values](image)

**Figure 5.** Average pill height values (mm) of the fabrics

![Graph showing weighted pills](image)

**Figure 6.** The weighted pill densities of the fabrics
As evaluated Figure 6, the positive effect of softeners can be seen obviously. The numbers of weighted pills of untreated fabrics were higher than that of softened fabrics. Particularly, the numbers of weighted pills of softened fabrics with softener S6 were lowest. While the number of washing cycles rose, weighted pill density increased greatly as well. As washing cycles were 20, weighted pill density was highest for all fabrics.

**Evaluation of Fuzz Loft**

Figure 7 shows the fuzz lofts of untreated and treated bamboo fabrics.

The fuzz loft values of untreated fabrics were higher than that of softened fabrics. The softeners had positive effect. After 20 washings, softener S6 had the lowest fuzz loft values. There was some fuzz on surface of the fabrics before washing. After washings, this fuzz was moved away from the fabric and the surface of the fabrics became smoother.

### 4. CONCLUSION

In this study, it was aimed to investigate systematically the effect of different softeners on pilling properties and durability to laundering of bamboo knitted fabrics. According to the results, the following consequences were obtained:

It was found that the softeners generally decreased the pilling formation on bamboo knitted fabrics and the effect of softeners was positive. Commonly, the multiple washings caused increases in pilling formation due to the intensive mechanical effect during laundering on bamboo knitted fabrics.

Among the softeners, before washing Softener S4 (cationic softener) and Softener S6 (mixture of carbamino derivative and micro silicone) were the best. Compared to the other softeners, Softener S4 and Softener S6 caused in reduce notably fiber-fiber frictions and provided to the yarn surface more slippery and softness. Therefore, these softeners prevented the pilling formation.

Only Softener S6 was more durable to washing. It is thought that this is because of the synergistic effect of micro silicone and carbamino derivative. Moreover, micro silicone penetrates easily into the fibers due to the low molecule size and this softener cannot remove from the fibers during washing.

### REFERENCES