

## Investigating Wrinkle Resistance of Cotton and Cotton Blended Fabrics in Relation to A Non-Formaldehyde Durable Press Finish

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Cotton is composed of cellulose molecules that have crystalline, amorphous, and intermediate regions of the cotton fiber (Lam et al., 2011). Wrinkle resistance on cotton fabrics can be obtained through crosslinking cellulose molecular chains by holding adjacent molecular chains together and creating covalent bonds to prevent from folding deformation or wrinkles (Tusief et al., 2014). Wrinkle resistant or durable press finishes have involved in a series of chemical agents such as urea and formaldehyde that crosslink cellulose-based molecular chains of cotton (Karthik et al., 2014). Cotton fabrics treated with a durable press finish have wrinkle resistance and improve ease care, dimensional stability, and pilling resistance. Conventional formaldehyde based crosslinking agents increase wrinkle resistance and durable press performance but also reduce strength of the fabric, increased stiffness, caused yellowing of the fabric, and it releases formaldehyde, which is a dangerous carcinogen, not safe for the skin (Karthik et al., 2011; Tania et al., 2018). Some durable press finishes use chemical reagents free of formaldehyde which are dimethyl dihydroxy ethylene urea (DMDHEU), dihydroxy dimethyl imidazolidinone (DHDMI), or polycarboxylic acids such as citric acid and butane tetracarboxylic acid (Karthik et al., 2011; Tusief et al., 2014). Prior research has shown that cotton fabrics with a durable press finish with PUREPRESS™ technology has up to 14x better abrasion resistance, 27% improvement in tensile strength and almost 27% improvement in tear strength compared to standard durable press finishes (Cotton Incorporated, n.d.). A durable press finish with PUREPRESS™ technology is applied through a pad, dry, and cure fabric application process, treated with non-formaldehyde crosslinking resins. This also helps improve wrinkle resistance, smoothness, shape retention, and reduce pilling as well as avoiding yellowing, shade changes, and odor (Cotton Incorporated, n.d.).

Many consumers have conflicting feelings about wrinkle resistance in garments (Epaminondas, 2016). They appreciate the convenience of not having to iron a garment, however, chemical resins make their garments stiff and uncomfortable to wear (Epaminondas, 2016). More alternatives are needed to achieve wrinkle resistance in cotton fabrics to improve wrinkle and abrasion resistance while remaining formaldehyde-free (Cotton Incorporated, n.d.). Few studies investigated a non-formaldehyde durable press finish to improve cotton fabric's wrinkle resistance ((Lam et al., 2011; Tusief et al., 2014). This study will help fill a literature gap about the non-formaldehyde durable press finish—an alternative option consumers can have for comfortable, wrinkle resistant garments. Thus, the purpose of this study was to investigate cotton fabric's wrinkle resistance treated by the durable press finish with formaldehyde-free crosslinking agents and compare with 100% cotton and cotton blended fabrics with/without conventional wrinkle resistance finishes.

In this study, eight fabrics were sampled: (1) 100% cotton fabric with a non-formaldehyde durable press finish with PUREPRESS™ technology, (2) 100% cotton fabric, (3) cotton blended fabrics with polyester—65% polyester 35% cotton, (4) cotton blended fabrics with polyester (Men's shirt)—55% cotton and 45% polyester, (5) cotton blended fabrics with spandex and wrinkle resistance claim—62% cotton 36% polyester 2% spandex (Men's pant), (6) polyester blended fabrics with spandex and wrinkle resistance claim (Men's pant)—63% polyester 33% rayon 4% spandex, (7) cotton blended fabric with

spandex and wrinkle resistance claim—60% cotton 36% recycled polyester 4% spandex (Women's shirt), and (8) 97% cotton 3% spandex fabric with the wrinkle resistance claim (Men's shirt). Fabric samples were examined through AATCC 128 Wrinkle Recovery of Fabrics: Appearance Method. Three trained researchers evaluated each specimen based on a comparison with the wrinkle recovery replicas: *WR 5—good wrinkle recovery and WR 1—poor wrinkle recovery*. This method determines the appearance of textile fabrics after induced wrinkling. Using IBM SPSS Statistics, one-way between groups analysis of variance (ANOVA) was conducted to compare differences of wrinkle resistance among the 24 specimens, depending on different fiber contents, wrinkle resistant finishes vs. non-wrinkle resistance finishes, and PUREPRESS™ vs. non- PUREPRESS™. *Post-hoc* comparisons were also conducted by using the *Bonferroni* test.

Results show that 100% cotton with the non-formaldehyde durable press finish using PUREPRESS™ technology obtained the highest mean score of wrinkle resistance (4.78), followed by 63% polyester 33% rayon 4% spandex with wrinkle resistance finish (4.44), 100% cotton (3.22), 65% polyester 35% cotton (3.2), 60% cotton 36% recycled polyester 4% spandex with wrinkle resistance finish (3), 62% cotton 36% polyester 2% spandex with wrinkle resistance finish (2.22), 55% cotton and 45% polyester (2.11), and 97% cotton 3% spandex fabric with wrinkle resistance finish (2.11). Significant differences were determined between the 100% cotton fabric with PUREPRESS™ technology and the other cotton and cotton blended fabrics without PUREPRESS™ technology:  $F(1, 22)=11.45, p<.01$ . *Post-hoc* comparisons using the *Bonferroni* test indicated the mean score of wrinkle resistance for the 100% cotton fabric with PUREPRESS™ technology ( $M=4.78, SD=.39$ ) was significantly different from the other fabrics without PUREPRESS™ technology ( $M=3.03, SD=.87$ ). Regarding the impact of wrinkle resistance finish on cotton and cotton blended fabrics, significant differences existed among the 100% cotton fabric with PUREPRESS™ technology, cotton blends with wrinkle resistance finish, and cotton or cotton blends without wrinkle resistance finish:  $F(2, 21)=5.69, p<.05$ . *Post-hoc* comparisons using the *Bonferroni* test indicated the mean score of wrinkle resistance for the 100% cotton fabric with PUREPRESS™ technology ( $M=4.78, SD=.38$ ) was significantly different from the other fabrics with wrinkle resistance finish ( $M=2.94, SD=1.03$ ) and without wrinkle resistance finish ( $M=3.14, SD=.61$ ). There was no statistically significant difference for wrinkle resistance between the cotton blended fabrics with and without wrinkle resistance finish. This result implies current wrinkle resistant fabrics might not significantly differ from non-wrinkle resistant fabrics. Concerning the impact of different fiber contents on wrinkle resistance, there were statistically significant differences among 100% cotton with PUREPRESS™ technology, 100% cotton, cotton blend with polyester, cotton blend with polyester and spandex, cotton blend with spandex, and polyester blend with rayon and spandex:  $F(5, 18)=11.31, p<.001$ . These results indicate a significant impact of different fiber contents on wrinkle resistance.

In summary, cotton fabric's wrinkle resistance treated by the durable press finish with formaldehyde-free crosslinking agents showed better wrinkle resistance than 100% cotton and cotton blended fabrics with/without wrinkle resistance finishes. There were differences for wrinkle resistance, depending on fiber contents and types of wrinkle resistant finishes. Thus, selection of fiber content and wrinkle resistant finish will significantly influence wrinkle resistance. According to prior research, the non-formaldehyde durable press finish has other properties, such as abrasion resistance, shape retention, pilling resistance, and so on. Further research on these properties is needed to explore characteristics of the non-formaldehyde durable press finish, compared with other wrinkle-resistant finishes (Tania et al., 2018; Tusief et al., 2014; Xu & Wang, 2012).

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