



Research Article

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

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Abstract

This study investigated cotton fabric's wrinkle resistance with a durable press finish, compared to 100% cotton and cotton blended fabrics. Wrinkle resistance of cotton fabrics can be achieved by using chemical resin finishes or blending with polyester, nylon, or spandex. Most of wrinkle resistance finishes contain harmful chemicals such as formaldehyde. However, a durable press finish through pad, dry, and cure fabric application process is treated with crosslinking resins, and it improves wrinkle resistance and is formaldehyde-free, making it a prime alternative to the wrinkle resistance finishes with formaldehyde. Eight different cotton and cotton-blended fabric samples were tested in relation to a non-formaldehyde durable press finish. The fabric samples were tested using AATCC 128 Wrinkle Recovery of Fabrics: Appearance Method. One-way between groups ANOVAs were conducted to examine how wrinkle resistance differs among the fabric samples, depending on fiber type, wrinkle resistant finishes, and non-formaldehyde durable press finish. *Post-hoc* comparisons using the *Bonferroni* test were also conducted. Results indicate that there were significant differences on wrinkle resistance by the different fiber contents and wrinkle resistance finishes. The 100% cotton fabric with the non-formaldehyde durable press finish showed greater wrinkle resistance than the other fabrics. The non-formaldehyde durable press finish also has other properties such as abrasion resistance, shape retention, pilling resistance, etc. Further research on these properties is needed to explore characteristics of the non-formaldehyde durable press finish, compared to other wrinkle resistant fabrics.

Introduction

Wrinkle resistant cotton fabrics are attractive to many consumers because there is no need for ironing [1]. Consumers want their cotton clothing to look like it is good quality by opting for a wrinkle-free garment without the worry of having to iron the garment before wearing. According to Tovey's study (1961:148), "wrinkle resistance is a property of a fabric which causes it to recover from folding deformations." Folding deformations can occur just from sitting too long in the garment. Some wrinkles do not always relax on their own, so there are ways to help keep fabrics wrinkle-free, such as chemical resins or blended fabrics.

Cotton is composed of cellulose molecules with crystalline, amorphous, and intermediate regions of the cotton fiber. Wrinkle resistant 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 [1]. Wrinkle resistant or durable press finishes involve a series of chemical agents, such as urea and formaldehyde, that crosslink cellulose-based molecular chains of cotton, rayon, and linen [2]. Cotton fabrics treated with a durable press finish have wrinkle resistance and improve ease care, dimensional stability, and pilling resistance.

According to prior studies, conventional urea and formaldehyde resin finishes cause excess release of a human carcinogen—a substance that causes cancer, odor, toxicity, and loss of tensile strength [3]. Especially, formaldehyde-based crosslinking agents, which increase wrinkle resistance and durable press performance, reduce fabric strength, increase stiffness, cause fabric yellowing, and release formaldehyde—a dangerous carcinogen, unsafe for skin [3]. Some durable press finishes use chemical reagents free from formaldehyde, such as dimethyl dihydroxy ethylene urea (DMDHEU), dihydroxy dimethyl imidazolidinone (DHDMI), or polycarboxylic acids—citric acid and butane tetracarboxylic acid [1]. Non-formaldehyde durable press finishes also use a catalyst or co-catalyst, such as titanium dioxide to enhance wrinkle resistance, and tensile and tearing strength. The blending of fabrics can also be a method to achieve wrinkle resistance but may not be as reliable as using chemical resins.

Prior research has identified using chemical resins to achieve wrinkle resistance can be dangerous, create stiffness in fabrics, and reduce abrasion resistance [3]. More alternatives are needed to achieve wrinkle resistance in fabrics, such as a durable press with PUREPRESS™ technology created by Cotton Incorporated. PUREPRESS™ technology treats a cotton fabric with a durable press finish to improve wrinkle and abrasion resistance, while remaining formaldehyde-free (Cotton Incorporated, 2019). Prior research has shown cotton fabrics with a durable press finish using PUREPRESS™ technology has almost 14x better abrasion resistance, 27% improvement in tensile strength, and almost 27% improvement in tear strength compared to standard durable press finishes (Cotton Incorporated, 2019). A durable press finish with PUREPRESS™ technology is applied through a pad, dried, and cured via a fabric application process, then treated with non-formaldehyde crosslinking resins. This technology 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 appreciate the convenience of not ironing a cotton garment. However, chemical resins make cotton garments stiff and uncomfortable to wear [4]. According to an article in the Wall Street Journal, many consumers have conflicting feelings about wrinkle resistant garments [4]. 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.). However, few studies have investigated a non-formaldehyde durable press finish to improve cotton fabric's wrinkle resistance [1]. This study will help fill a literature gap about the non-formaldehyde durable press finish—a consumer alternative option for comfortable, wrinkle resistant garments. Thus, the purpose of this study is 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 and without conventional wrinkle resistance finishes. Findings from this study will provide an understanding about wrinkle resistance of the durable press finish with formaldehyde-free crosslinking agents—an alternative choice for both apparel brands and consumers [5].

Literature Review

Prior research in wrinkle resistance

Since the 1920s and gaining strides in the 1940s and 1950s, past research noted wrinkle resistance in garments, specifically cotton [6]. During the 1920s, chemical finishes were created to help wrinkle resistance in garments. Because of side effects, further work was completed later during the century [6]. During the 1940s more research improved wrinkle resistant finishes, but few were regularly used [2]. During the 1950s, research was aimed to combat wrinkles in fabrics.

Chemical resins, crosslinking agents, and non-chemical resins are examples of wrinkle resistant techniques in garments. According to prior research, chemical resins were used to remove wrinkles in fabrics [7], who found chemical reactions within the cellulosic fiber created cellulosic chains with adjacent fibers and produced wrinkle resistance in fabrics. Such chemicals were formaldehyde and urea melamine. This chemical finish was tested on cotton and rayon fabrics. Cooke, et al. [7] showed fabrics increased in elasticity, making them less capable wrinkling. As a result, both cotton- and rayon-treated fabrics increased their wrinkle resistance.

Another study by Hurwitz [8] used the application of a conventional crease-proofing formulation to cotton garments. All crease-resistant finishes contained a thermosetting resin, such as urea formaldehyde, cyclic urea formaldehyde, or melamine formaldehyde. Results from the study showed this treatment was satisfactory on some garments, but not all. Another study used resin treatments to improve cotton in terms of wash and wear, and garments without ironing [9]. Murphy, et al. [10] tested using resins and crosslinking agents and found using fewer crosslinks resulted in better wrinkle resistance [11].

In a more recent study, five chemical crosslinking agents were applied to cotton fabrics, and tests were completed on treated and untreated fabrics [3]. Tania, et al. [3] tested different levels of a formaldehyde-based crosslinking agent from low to high on the different fabrics: the first, contained the lowest level of formaldehyde to the fifth, which contained the highest level of formaldehyde. According to their study, the finished fabric had an increased crease recovery, smoothness, and wrinkle-free appearance using the highest level of formaldehyde. The formaldehyde-based crosslinking agent increased wrinkle resistance and durable press performance, but also reduced fabric strength, increased stiffness, caused fabric yellowing, and was unsafe for skin [3].

Since formaldehyde is a crosslinking agent with the most success in obtaining wrinkle resistance, but is dangerous for humans, other studies were completing to combat wrinkles in fabrics. Other studies have used a non-chemical resin to achieve wrinkle resistance. One example is a study that used six vegetable oils on 100% cotton fabric [2]. This study did not include toxic chemicals—a good alternative for formaldehyde. Stefanovic, et al. [2] showed fattier acids in the oils were an important factor for wrinkle resistant fabrics' recovery properties. More studies are needed to determine the effect of vegetable or plant-based oils on wrinkle resistance.

Blended fabrics can be another way to obtain wrinkle resistance within fabrics without using harmful chemicals. In a study completed by Yokura and Niwa [12], the durability of spandex blended fabrics was examined. Wear tests and lab simulations were completed to test the mechanical properties of spandex blended fabrics [12]. Their research found wrinkle resistant spandex-blended fabrics was stronger than conventional fabrics [12]. More studies are needed to determine if blended fabrics with spandex can enhance both wrinkle resistance and durability.

Durable press finish for wrinkle resistance

An alternative for wrinkle resistance is a durable press finish, such as Cotton Incorporated's PUREPRESS™ technology. Cotton Incorporated is known to look for sustainable practices to increase appeal for cotton in the fashion industry (Cotton Incorporated, 2018); thus, they created PUREPRESS™ technology with crosslinking resins, formaldehyde-free, which improves fabrics' wrinkle resistance, and includes easy care performance (Cotton Incorporated, 2019). PUREPRESS™ technology is a durable press finish applied through pad, dried, and cured. Their process helps improve wrinkle resistance, smoothness, shape retention, and reduce pilling, as well as avoid yellowing, shade changes, and odor (Cotton Incorporated, 2019).

Compared to most crosslinking resins in past studies, the PUREPRESS™ resin cotton technology is formaldehyde-free. Formaldehyde can weaken fibers and affect abrasion resistance within fabrics. The PUREPRESS™ finish has wrinkle resistance properties along with abrasion resistance properties—a great substitute to the negative effects of chemical finishes. Cotton Incorporated has created an alternative to resolve many problems people face with fabrics containing safe chemicals. This technology is very attractive, and needs compared with other fabrics to empirically test its wrinkle resistance.

Methodology

Samples

In this study, eight fabrics were sampled, including (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, purchased at a mass merchant store)—55% cotton 45% polyester, (5) cotton blended fabrics with spandex and wrinkle resistance claims—62% cotton 36% polyester 2% spandex (Men's Khaki Pant "Straight Premium Khaki Pant," purchased at a mass merchant store), (6) polyester blended fabrics with spandex and wrinkle resistance claim (Men's Khaki Pant "Straight Premium Khaki Pant," purchased at a mass merchant store)—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, purchased at a mass merchant store), and (8) 97% cotton 3% spandex fabric with the wrinkle resistance claim (Men's shirt, purchased at a mass merchant store). All fabrics and apparel products are plain weave and lightweight, except the 100% cotton fabric with the PUREPRESS™ technology, and the cotton blended fabric with spandex and wrinkle resistance claim—62 cotton 36% polyester 2% spandex are twill weave.

Test methods

Fabric samples were examined through AATCC standard test methods for wrinkle recovery using AATCC 128 Wrinkle Recovery of Fabrics: Appearance Method. This method determines the appearance of textile fabrics after induced wrinkling. Following AATCC 128, a total of 24 specimens with size 6 in. x 11 in. were cut and conditioned for a minimum of 8 hours at 21 ± 1 °C (70 ± 2 °F) and 65 ± 2 % RH in a standard atmosphere and wrinkled under 3500 grams weight (3.5 kg) for 20 minutes in a wrinkle recovery tester. Then, the specimens were hung on a clothesline for 24 hours. Three trained researchers evaluated the specimens using the wrinkle recovery replica (1-5) grade 5—*good wrinkle recovery* and grade 1—*poor wrinkle recovery*. Excellent wrinkle resistance indicates the specimen's recovery from wrinkles is strong after creases have been made.

Data analysis

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 a durable press finish without formaldehyde—PUREPRESS™ technology—vs. non-durable press finish. This study examined how wrinkle resistance differs among specimens, depending on fiber type, wrinkle resistant finishes, durable press finish without formaldehyde—PUREPRESS™ technology. *Post-hoc* comparisons were also conducted using the *Bonferroni* test.

Results

As shown in Table 1, 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/claim (4.44), 100% cotton (3.22), 65% polyester 35% cotton (3.2), 60% cotton 36% recycled polyester 4% spandex with wrinkle resistance finish/claim (3), 62% cotton 36% polyester 2% spandex with wrinkle resistance finish/claim (2.22), 55% cotton 45% polyester (2.11), and 97% cotton 3% spandex fabric with wrinkle resistance finish/claim (2.11).

Table 1: Test Results of AATCC 128 Wrinkle Recovery of Fabrics: Appearance Method.

Specimens	1	2	3	Mean
100% cotton fabric with PUREPRESS™ technology	5.00	5.00	4.33	4.78
100% cotton fabric	4.00	3.33	2.33	3.22
Cotton blended fabrics with polyester: 65% polyester 35% cotton	2.67	4.00	3.00	3.20
Cotton blended fabrics with polyester: 55% cotton and 45% polyester	2.33	2.00	2.00	2.11
Cotton blended fabrics with wrinkle resistance: 62% cotton 36% polyester 2% spandex	2.33	2.67	1.67	2.22
Polyester blended fabrics with wrinkle resistance: 63% polyester 33% rayon 4% spandex	4.33	4.67	4.33	4.44
Cotton blended fabric with spandex and wrinkle resistance finish: 60% cotton 36% recycled polyester 4% spandex	3.33	3.33	2.33	3.00
97% cotton 3% spandex fabric with wrinkle resistance	2.00	2.00	2.33	2.11

Note: Wrinkle recovery replica (1-5) grade 5—good wrinkle recovery and grade 1—poor wrinkle recovery.

One-way between groups analysis of variance (ANOVA) with *post-hoc* tests were conducted to explore the impact of the durable press finish without formaldehyde—PUREPRESS™ technology—on wrinkle resistance. Data were divided into two groups: 100% cotton fabric with the PUREPRESS™ technology and other fabrics without the PUREPRESS™ technology. There were statistically significant differences between the two groups: $F(1, 22) = 11.45, p < .01$. The effect size, calculated using eta squared, was .34. *Post-hoc*

comparisons using the *Bonferroni* test indicated the mean score of wrinkle resistance for the 100% cotton fabric with the PUREPRESS™ technology ($M = 4.78, SD = .39$) was significantly different from the other fabrics without the PUREPRESS™ technology ($M = 3.03, SD = .87$) (see Tables 2 and 3). Results indicate a significant impact of the PUREPRESS™ technology on wrinkle resistance. The 100% cotton fabric with the PUREPRESS™ technology showed greater wrinkle resistance than the other fabrics.

Table 2: Results of one-way between-groups ANOVA comparing wrinkle resistance of PUREPRESS™ and Non PUREPRESS™ finish.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	8.00	1	8	11.45	0.003
Intercept	160.00	1	160	228.835	<.001
PUREPRESS™ Technology	8.00	1	8	11.45	0.003
Error	15.38	22	0.7		
Total	276.69	24			
Corrected Total	23.39	23			

Note: R -Squared = .34 (Adjusted R -Squared = .31)

Table 3: Post-hoc Comparison between PUREPRESS™ and Non PUREPRESS™ finish using Bonferroni test.

(I)	(J)	Mean Difference (I-J)	Sig.
Non_PurePress	PurePress	-1.75*	0.003
PurePress	Non_PurePress	1.75*	0.003

Note: *The mean difference is significant at the .05 level.

To investigate the impact of wrinkle resistance finish on wrinkle resistance, data were divided into three groups: 100% cotton fabric with the durable press finish without formaldehyde—PUREPRESS™ technology, cotton blends with wrinkle resistance finish, and cotton or cotton blends without wrinkle resistance finish. Regarding the impact of wrinkle resistance finish on cotton and cotton blended fabrics, significant differences existed among the 100% cotton fabric with the durable press finish without formaldehyde—PUREPRESS™ technology, cotton blends with wrinkle resistance finish, and cotton or cotton blends without wrinkle resistance finish: $F(2, 21) = 5.69, p < .05$. The effect size, calculated using eta squared, was .35. *Post-hoc* comparisons using

the *Bonferroni* test indicated the mean score of wrinkle resistance for the 100% cotton fabric with the durable press finish without formaldehyde—PUREPRESS™ technology ($M = 4.78, SD = .38$) was significantly different from the other fabrics with wrinkle resistance finish/claim ($M = 2.94, SD = 1.03$) and without wrinkle resistance finish/claim ($M = 3.14, SD = .61$) (see Tables 4 and 5). There was no statistically significant difference of wrinkle resistance between the cotton blended fabrics with and without wrinkle resistance finish/claim. This result implies current wrinkle resistant fabrics on the market might not significantly differ from non-wrinkle resistant fabrics, and the quality of wrinkle resistance is inconsistently obtained in the wrinkle resistance finished/claimed fabrics.

Table 4: Results of one-way between-groups ANOVA comparing wrinkle resistance among PUREPRESS™ technology, wrinkle resistance finish, and non-wrinkle resistance finish.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	8.22	2	4.11	5.69	0.011
Intercept	223.74	1	223.74	309.73	<.001
WR Finish	8.22	2	4.11	5.69	0.011
Error	15.17	21	0.72		
Total	276.69	24			
Corrected Total	23.39	23			

Note: *R-Squared* = .351 (*Adjusted R-Squared* = .29)

Table 5: Post-hoc Comparisons among PUREPRESS™, wrinkle resistance finish, and non-wrinkle resistance finish through Bonferroni test.

(I)	(J)	Mean Difference (I-J)	Sig.
PUREPRESS™	WR Finish	1.83*	0.009
	Non WR Finish	1.63*	0.027
WR Finish	PUREPRESS™	-1.83*	0.009
	Non WR Finish	-0.2	1.000
Non WR Finish	PUREPRESS™	-1.63*	0.027
	WR Finish	0.2	1.000

Note: *The mean difference is significant at the .05 level.

To examine the impact of different fiber contents on wrinkle resistance, data were divided into six groups according to their fiber contents: 100% cotton with the durable press finish without formaldehyde— PUREPRESS™ technology, 100% cotton, cotton blended with polyester, cotton blended with polyester and spandex, cotton blended with spandex, and polyester blended with rayon and spandex. There were statistically significant differences among the six different fiber contents: $F(5, 18) = 11.31, p < .001$. The effect size, calculated using eta squared, was .76. *Post-hoc* comparisons

using the *Bonferroni* test indicated the mean score of wrinkle resistance for 100% cotton with the durable press finish without formaldehyde— PUREPRESS™ technology ($M=4.78, SD=.39$) was significantly different from the other fabrics except polyester blend with rayon and spandex (see Tables 6 and 7). Results indicate a significant impact of different fiber contents on wrinkle resistance. The 100% cotton fabric with the durable press finish without formaldehyde— PUREPRESS™ technology—showed greater wrinkle resistance than the other fabrics (See Table 8).

Table 6: Descriptive statistics of wrinkle resistance by different fiber contents.

Fiber Type	Mean	Std. Deviation	n
100% Cotton with PUREPRESS™ technology	4.78	0.39	3
100% Cotton	3.22	0.84	3
Cotton Poly	3.11	0.58	6
Cotton Poly Spandex	2.61	0.65	6
Cotton Spandex	2.11	0.19	3
Poly Rayon Spandex	4.44	0.2	3
Total	3.25	1.01	24

Note: *R-Squared* = .76 (*Adjusted R-Squared* = .69)

Table 7: Results of one-way between-groups ANOVA comparing wrinkle resistance by different fiber contents.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	17.74	5	3.55	11.31	<.001
Intercept	246.52	1	246.52	786.04	<.001
Fiber Type	17.74	5	3.55	11.31	<.001
Error	5.65	18	0.31		
Total	276.69	24			
Corrected Total	23.39	23			

Note: *R-Squared* = .76 (*Adjusted R-Squared* = .69)

Table 8: Post-hoc Comparisons of wrinkle resistance by different fiber contents through Bonferroni test.

(I)	(J)	Mean difference (I-J)	Sig.
100% Cotton with PUREPRESS™	100% Cotton	1.56*	0.047
	Cotton Poly	1.67*	0.008
	Cotton Poly Spandex	2.17*	<.001
	Cotton Spandex	2.67*	<.001
	Poly Rayon Spandex	0.33	1.000
100% Cotton	100% Cotton PUREPRESS™	-1.56*	0.047
	Cotton Poly	0.11	1.000
	Cotton Poly Spandex	0.61	1.000
	Cotton Spandex	1.11	0.389
	Poly Rayon Spandex	-1.22	0.232
Cotton Poly	100% Cotton PUREPRESS™	-1.67*	0.008
	100% Cotton	-0.11	1.000
	Cotton Poly Spandex	0.50	1.000
	Cotton Spandex	1.00	0.317
	Poly Rayon Spandex	-1.33	0.051
Cotton Poly Spandex	100% Cotton PUREPRESS™	-2.17*	<.001
	100% Cotton	-0.61	1.000
	Cotton Poly	-0.50	1.000
	Cotton Spandex	0.50	1.000
	Poly Rayon Spandex	-1.83*	0.003
Cotton Spandex	100% Cotton PUREPRESS™	-2.67*	<.001
	100% Cotton	-1.11	0.389
	Cotton Poly	-1.00	0.317
	Cotton Poly Spandex	-0.50	1.000
	Poly Rayon Spandex	-2.33*	0.001
Poly Rayon Spandex	100% Cotton PUREPRESS™	-0.33	1.000
	100% Cotton	1.22	0.232
	Cotton Poly	1.33	0.051
	Cotton Poly Spandex	1.83*	0.003
	Cotton Spandex	2.33*	0.001

Note: *The mean difference is significant at the .05 level.

Discussion

The purpose of this study was to examine cotton fabric's wrinkle resistance treated with the durable press finish with formaldehyde-free crosslinking agents by comparing with cotton and cotton blended fabrics with and without wrinkle resistance finishes. Overall, the 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 contents and wrinkle resistant finish will significantly influence wrinkle resistance.

Results indicated 100% cotton fabric with the non-formaldehyde durable press finish showed better wrinkle resistance than the other cotton or cotton blended fabrics (Mean difference = 1.75). This result empirically validated excellence of the non-formaldehyde durable press finish on wrinkle resistance. Regarding the significant impact of wrinkle resistant finish on cotton and cotton blended fabrics, the 100% cotton fabric with the non-formaldehyde durable press finish had greater wrinkle resistance than the cotton or cotton blends with wrinkle resistance finish (Mean difference = 1.83) and without wrinkle resistance finish (Mean difference = 1.63). Interestingly, there was no significant difference between current wrinkle resistant fabrics and non-wrinkle resistant fabrics (Mean difference = .20). This result indicates existing wrinkle resistant finished fabrics in the market

may guarantee a wrinkle resistance function inconsistently.

Concerning the significant impact of different fiber contents on wrinkle resistance, 100% cotton with the non-formaldehyde durable press showed the best wrinkle resistance, followed by polyester blend with rayon and spandex (Mean difference = .33), 100% cotton (Mean difference = 1.56), cotton blend with polyester (Mean difference = 1.67), cotton blend with polyester and spandex (Mean difference = 2.17), and cotton blend with spandex (Mean difference = 2.67). There was no significant mean difference between 100% cotton with the non-formaldehyde durable press and polyester blend with rayon and spandex. Interestingly, blending with polyester provided greater wrinkle resistance than blending with spandex. Further investigation of 100% cotton's wrinkle resistance is needed, as it showed greater wrinkle resistance than cotton blends.

Prior research noted a formaldehyde resin has been used in the past to achieve wrinkle resistance in fabrics [3], but through this study cotton fabric's wrinkle resistance can be obtained through the durable press finish with formaldehyde-free crosslinking agents. Other finishes besides harmful chemicals, such as vegetable oils, can be used to achieve wrinkle resistance in fabrics, but have yet to be further researched [2]. Prior research indicates wrinkle resistance of spandex blended fabrics can be more wrinkle resistant than conventional fabrics [12]. This may explain why the 63% polyester 33% rayon 4% spandex fabric obtained significant results in this study. Blending with both polyester and spandex could be suggested to enhance wrinkle resistance.

Academically, this study contributes to fill a gap in the literature about wrinkle resistance of the non-formaldehyde durable press finish. Findings from this study will also provide valuable information about effects of different finishes and fiber contents on wrinkle resistance. Industrial implications from this study may include suggesting alternative ways to obtain wrinkle resistance to the fashion industry. A non-formaldehyde durable press finish, such as the PUREPRESS™ technology, can be an alternative, since it improves wrinkle resistance, smoothness, shape retention, durability, abrasion resistance, colorfastness, and pilling resistance (Cotton Incorporated, 2019). Findings from this study will help consumers make a smarter decision when they engage in purchasing wrinkle resistance finished apparel products.

According to prior research, the non-formaldehyde durable press finish has other properties, such as durability, abrasion resistance, smoothness, shape retention, pilling resistance, colorfastness, and so on. Further research on these properties is

needed to explore characteristics of the non-formaldehyde durable press finish, compared to other conventional wrinkle resistant finishes [1,3]. Future research is also suggested to investigate effects of a wider variety of fiber contents, fabric types, non-formaldehyde wrinkle resistant finishes, and alternative finishes on wrinkle resistance.

Acknowledgement

None.

Conflict of Interest

Authors declare no conflict of interest.

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