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Identifying the Shrinkage Properties of Cotton Polyester Spandex Denim Fabrics of Different Fiber Content

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Abstract

The aim of this research is to investigate the shrinkage properties of cotton polyester spandex denim fabrics of different fiber content. Cotton fabrics with spandex have a tendency to shrink when it comes in contact of water. Cotton spandex shrinks more when it comes in contact of hot water. Cotton is swelled up in water; thereby increase the width of fibers, as a result there is the decrease of length. If the cotton composition with spandex increases, the shrinkage properties of fabrics also increase. The higher the percentage of spandex content in a fabric is, the higher the values of shrinkage are. On the other hand, polyester does not shrink when it comes in contact of water, as manmade polyester fibers do not swell up in water. Three nomenclature of cotton poly spandex denim fabrics of different composition were used in this research and to do the required tests. Finished fabrics were collected from fabric mill to do the required tests in AATCC Test Method 135. This experiment proved that, the properties of shrinkage depends on the composition of cotton, polyester and spandex and it created a suitable way for the scholars to further study in this field.

Keywords: Cotton poly spandex; Shrinkage properties; Denim fabrics; Fiber content; Swelling property

Introduction

There is a great importance of this research in denim industries as the task of controlling shrinkage of cotton polyester spandex denim fabric is always challenging. It is natural that, cotton fiber will shrink when it comes in contact of water. If the cotton content in the fabric is reduced, the shrinkage properties would also be reduced. Trials were must in this research to get the different shrinkage values. This research established that, if the cotton percentage in the blend is reduced, then the shrinkage values would also be reduced. Different scholars worked related to this subjected matter at different times where literature review revealed different results. Some of which were similar and others were widely dissimilar. Shariful et al. reported that heat setting had some direct consequences on the shrinkage properties of cotton spandex woven fabrics [1].

Shariful et al. also experimented that optimized strength of cotton spandex woven fabrics could be obtained by proper heat setting with some adjusted industrial setting [2]. Shariful et al. proved that heat setting optimized the elastic performances of cotton spandex woven fabrics. Shariful et al. also experimented that the application of precious temperature enhanced the elastic performance like stretch, growth and recovery of cotton spandex woven fabrics [3]. Shariful et al., experimented that the percentage of polyester content in the cotton polyester blend increases the strength of woven fabrics [4]. Tezel et al., reported that if the cotton percentage in the blends is higher, the shrinkage will also be higher and also if the percentage of spandex in the cloths is higher, the shrinkage will also be higher [5]. Sarkeshick et al., reported that cotton spandex fabric shrinks more when it is taken from the manufacturing area just after weaving or knitting. Cotton spandex fabrics will show more shrinkage property when they are in the wet processing zones. After making the cloths they will shrink less, as in the wet processing zones, they shrink as much as they can [6]. Gokarneshan et al., experimented that cotton fibers will shrink in the contact of water but spandex will shrink in the contact of temperature either in the dryer or in the stenter machine with the blast of hot air blow or in hot water [7]. Tian et al., also reported that, spandex will shrink less in the water of room temperature but it will start shrinking more when it will be washed in the hot water [8]. Chen et al., experimented that shrinkage depends on the percentage of cotton in the material. If the percentage of polyester in a blend is more, the shrinkage will be less because polyester does not shrink in normal water [9]. Chen et al., reported that shrinkage will be more in the higher percentage of cotton of the cotton spandex cloths, but garments will be damaged more if higher temperature is applied on the higher percentage of spandex [10]. Liu et al., experimented that polyester will not shrink in water as it does not absorb water. Polyester always resists shrinkage [11]. Hasan et al., also experimented that polyester is not made up with organic fibers; rather they are made up with manmade materials, where cellulose is absent. So, there is no chance for polyester to shrink when it comes in contact of water [12]. Ramasamy et al., reported that in case polyester is not heat set properly during production process, on that time, polyester may shrink in the dryer with temperature but not in water or in steam compartment. Higher temperature in the dryer may help to shrink the polyester fiber slightly [13]. Das et al., experimented that spandex yarns have haphazardness in the structure, proper heat setting can give the yarns a permanent rigid structure by changing the internal structure of spandex in yarns [14]. Uttam et al., proved that increasing the percentage of polyester in the blend with cotton also increase the abrasion resistances properties and the pilling performances of fabrics [15]. Uttam et al., proved that in the blend of cotton polyester fabrics, very little percentage of spandex like 2 to 3% is sufficient enough to enhance

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the elastic performance of fabrics [16]. Razali et al., experimented that increasing the polyester content percentage in an elastic fabric is a good practice to avoid creasing problem and also it guaranteed good abrasion resistance properties and pilling performances of fabrics [17-19]. The present researcher is conducted to experiment the shrinkage properties of cotton polyester spandex denim fabrics. Different cotton polyester spandex fabrics of different fiber content were used as mentioned in Table 1 to conduct the experiment and to do the required tests. This experiment was practice based and the findings was beneficial to the personnel involved in the textile industries who were responsible to control the dimensional stabilities or the shrinkage properties of cotton polyester spandex denim fabrics.

Materials and Method

Materials

Cotton polyester spandex denim fabric is the fundamental raw materials for this research. Cotton polyester blend along with spandex fibers were used in this research and to do the required tests. Different types of cotton poly spandex denim fabrics with different composition were used in this research as shown in Table 1. Finished raw denim fabrics were collected from fabric mills just after finishing is done and tests were carried out. Fabric of color blue indigo and Sulphur black were used for shrinkage testing (Table 1).

In Table 1, for the given construction in serial no A, 20× 10+20D)/122×54 shows a construction of a cotton polyester spandex fabric. Cotton polyester blending percentage is 65% cotton and 32% polyester. Along with this 3% spandex is inserted in weft way to provide elasticity. Here, warp yarn count is 20 which is a non-stretched yarn made up of cotton polyester blend, but weft yarn count is (10+20D) that means, spandex of 20 denier is used with the core of 10 count in weft way to make it stretched yarn. Thread density in ends per inch is 122 and picks per inch is 54. Two other constructions in serial no B and C show the same characteristics. It is clear that percentage of spandex content depends on the value of Denier. The more the denier value is, the more the percentage of spandex content is. It is seen that 3% spandex content is achieved from the yarn of (10+20D), 7% spandex content is achieved from the yarn of (10+40D) and 9% spandex content is achieved from the yarn of (10+70D).

Shrinkage test method

Shrinkage tests were carried out in accordance with the AATCC (American Association of Textile Chemists and Colorists) Test Method 135.18.

Shrinkage testing machine

Shrinkage is the procedure where a fabric becomes smaller than its original size habitually over the practice of laundry. Dimensional stability to washing or shrinkage of a fabric was measured after 3 washes in accordance with "AATCC Test Method 135" with the facilities of a "TESTEX shrinkage washer TF176". Figure 1 shows a shrinkage testing machine 19.

Preparation of the samples

Three types of cotton polyester spandex denim fabrics of different spandex content were collected from fabric mill just after finishing process is done for shrinkage testing as mentioned in Table 1. Using a measurement tape, sample size like "20-inch × 20-inch" was cut but "18-inch × 18-inch" was marked with permanent marker to prepare the fabric for shrinkage testing. Interlock stitching was given at the edge of the fabric before washing so that the yarns from the fabric could not be removed during heavy washing. This test method is applied to measure the dimensional changes of fabrics when subjected to home laundering. At first detergent washing was done for 90 minute with 60°C temperature. Secondly, the sample was rinse washed with room temperature for 45 minute. In rinse wash, fabric was just simply washed with normal clean water. Thirdly, extraction for 15 minutes and finally drying was done for 5 minute. After home laundry, shrinkage was measured with equation 1 in agreement with the AATCC Test Method 135 and shown the consequences in Tables 2-4. Figure 2 shows the arranged denim sample for shrinkage measurement (Figure 2).

$$\text{Shrinkage}\% = \left\{\frac{(\text{Washed Length} - \text{Initial Length})}{\text{Initial Length}}\right\} \times 100$$

Equation 1: Shrinkage measuring formula.

Experiment A

A specimen was taken that had a composition of 65% Cotton 32% Polyester and 3% Spandex with the construction of 20×(10+20D)/122×54, had a width of 51 inches, weight of 295 gm/m^2 and had a weave of 3/1 left handed twill for doing shrinkage test. Color of the fabric was blue indigo. Measurement of the length of the samples before and after washing was taken in both warp and weft way and found the consequences shown in Table 2. It is seen from the Table 2 that, before wash the warp length was 18", after wash the warp length was 17.25" and before wash the weft length was 18" and after wash the weft length was 16.25" (Table 2).

Experiment B

A specimen was taken that had a composition of 75% Cotton 18% Polyester and 7% Spandex with the construction of 20×(10+40D)/122×54, had a width of 51 inches, weight of 295 gm/m^2 and had a weave of 3/1 left handed twill for doing shrinkage test. Color of the fabric was Sulphur black. Measurement of the length of the samples before and after washing was taken in both warp and weft way and found the consequences shown in Table 3. It is seen from the Table 3 that, before wash the warp length was 18", after wash the warp length was 17" and before wash the weft length was 18", after wash the weft length was 15.50" (Table 3).

Experiment C

A specimen was taken that had a composition of 85% Cotton 6% Polyester and 9% Spandex with the construction of 20×(10+70D)/122×54 had a width of 51 inches, weight of 295 gm/m^2 and had a weave of 3/1 left handed twill for doing shrinkage test. Color of the sample was blue indigo. Measurement of the length of the samples before and after washing was taken in both warp and weft way and found the consequences shown in Table 4. It is seen from the Table

S.N	Composition	Construction	Weave	Color	Width (")	Weight (gm/m^2)
A	65% Cotton, 32% Polyester and 3% Spandex	20x(10+20D)/122x54	3/1 Left Handed Twill	Blue Indigo	51	295
B	75% Cotton, 18% Polyester and 7% Spandex	20x(10+40D)/122x54	3/1 Left Handed Twill	Sulphur Black	51	295
C	85% Cotton, 6% Polyester and 9% Spandex	20x(10+70D)/122x54	3/1 Left Handed Twill	Blue Indigo	51	295

Table 1: Cotton polyester spandex denim fabrics of different fiber content.

Figure 1: TESTEX shrinkage washer TF176 for shrinkage testing.

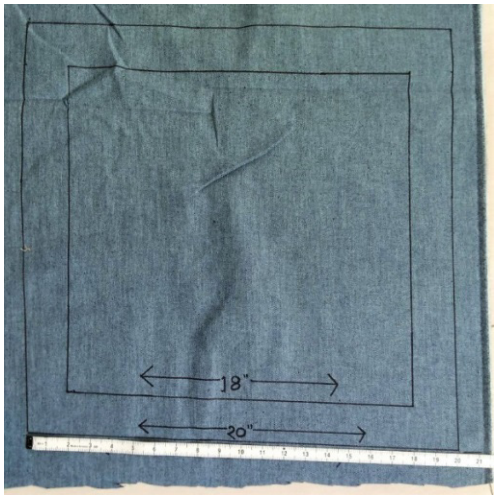

Figure 2: Sample Preparation for shrinkage testing.

	Before Wash ()	After Wash (")
Warp Length	18	17.25
Weft Length	18	16.25

Table 2: Measurement of warp and weft length of before and after washing.

	Before Wash ()	After Wash (")
Warp Length	18	17
Weft Length	18	15.50

Table 3: Measurement of warp and weft length before and after washing.

	Before Wash (")	After Wash (")
Warp Length	18	16.50
Weft Length	18	14.75

Table 4: Measurement of warp and weft length before and after washing.

4 that, before wash the warp length was 18", after wash the warp length was 16.50" and before wash the weft length was 18" and after wash the weft length was 14.75" (Table 4).

Result and Discussion

Experiments were carried out using three different nomenclatures mentioned in Table 1 with different fiber content and found the consequences of shrinkage shown in Tables 5-7. Using equation 1 and data obtained from Tables 2-4 shrinkage values were achieved.

Results of experiment A

It is seen from the Table 5 that, the fabric containing 65% Cotton 32% Polyester and 3% Spandex exposed the shrinkage values for warp -4.16% and for weft -9.72%. In this type of sample 3% spandex content with (10+20D) shows less shrinkage values compared to the others in this research. Cotton fibers and spandex shrink in water. Manmade elastic fiber shrinks more when it comes in contact of hot water. After laundry in hot water spandex and cotton shrinks more. On the other hand polyester does not have any swelling property and it does not absorb water. Thereby it is not influenced due to laundering.

Results of experiment B

It is seen from the Table 6 that, the fabric containing 75% Cotton 18% Polyester and 7% Spandex exposed the shrinkage values for warp -5.55% and for weft -9.72%. In this type of sample 7% spandex content with (10+40D) shows comparatively more shrinkage values than 3% spandex content with (10+20D). Higher denier with higher spandex content shows more shrinkage values since it shrinks more while laundering (Table 6). 75% cotton shrinks more in water compared to 65% cotton. Besides, 18% polyester shows more shrinkage values compared to 32% polyester. Cotton fibers and spandex shrink in water. Manmade elastic fiber shrinks more when it comes in contact of hot water. After laundry in hot water spandex and cotton shrinks more. On the other hand polyester does not have any swelling property and it does not absorb water. Thereby it is not influenced due to laundering.

Results of experiment C

It is seen from the Table 7 that, the fabric containing 85% Cotton 6% Polyester and 9% Spandex exposed the shrinkage values for warp -8.33% and for weft -18.05%. In this type of sample 9% spandex

		Values
1	Warp Shrinkage (%)	-4.16%
2	Weft Shrinkage (%)	-9.72%

Table 5: Warp and weft shrinkage for the composition of 65% cotton 32% polyester and 3% spandex.

		Values
1	Warp Shrinkage (%)	-5.55%
2	Weft Shrinkage (%)	-13.88%

Table 6: Warp and weft shrinkage for the composition of 75% cotton 18% polyester and 7% spandex.

S.no		Values
1	Warp Shrinkage (%)	-8.33%
2	Weft Shrinkage (%)	-18.05%

Table 7: Warp and weft shrinkage for the composition of 85% cotton 6% polyester and 9% spandex.

content with (10+70D) shows comparatively more shrinkage values than 3% spandex content with (10+20D) and 7% spandex content with (10+40D). Higher denier with higher spandex content shows more shrinkage values since it shrinks more while laundering. 85% cotton shrinks more in water compared to 75% cotton and 65% cotton. Besides, 6% polyester shows more shrinkage values compared to 32% polyester and 18% polyester content. Manmade elastic fiber shrinks more when it comes in contact of hot water. After laundry in hot water spandex and cotton shrinks more. On the other hand polyester does not have any swelling property and it does not absorb water. Thereby it is not influenced due to laundering.

Discussion

It is seen from the Tables 5-7 that shrinkage values were more for the fabrics of higher spandex content with higher spandex Denier. It was also noticed that, shrinkage values were more for the fabrics of higher cotton content but shrinkage values were less for the fabric of higher polyester content. The reason is that, cotton fabric has a tendency to shrink when it comes in contact to water. Cotton fibers shrink in water because they absorb water. When cotton absorbs water, they swell up, increase the width and there is a shortage of length, therefore shrinkage occurs. This incident happens more in hot water. Spandex fibers shrink more when temperature will be applied either in hot water or in steam compartment. Higher spandex content with higher denier values help the cotton fibers to shrink more then it's original state when submerged in water, that's why higher spandex content with cotton fibers give more shrinkage values. Therefore, the more the spandex content is, the more the shrinkage values are. On the other hand, manmade polyester does not swell in water and it does not shrink in contact of water. So, the more the polyester is, the less the shrinkage is.

Conclusion

In this experiment it was seen that, fiber composition had direct consequences on the shrinkage properties of cotton polyester spandex denim fabrics. Cotton fibers shrink in water due to its swelling property in water. So, the more the cotton fibers in a blend are, the more the shrinkage values are. Likewise, spandex fibers shrink more when it comes in contact of either in hot water or in steam compartment. When hot water, steam or hot air comes in contact of spandex content, then it shrinks due to its rubber like elasticity. Manmade polyester fibers never shrink in water as it does not have any swelling property in wet condition. If the polyester content is more in the blend, the shrinkage property will be less. Shrinkage properties may differ if the machine setting of shrinkage tester, time or temperature is changed. It is proved in the research that the fabric of 85% Cotton, 6% Polyester and 9% Spandex content shows most shrinkage values compared with other samples in this research due to the higher spandex content with higher denier values. Trials were carried out in textile mills with denim fabrics of various fiber content of cotton, polyester and spandex to study the irregular shrinkage properties found in elastic denim fabric. This research is practiced based and the findings are beneficial to the personnel involved in textile industries who are responsible for the manufacture of cotton spandex woven fabrics. This research opened several ways for the scholars to further study in this field.

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