To Examine the Effect of Alternate Spandex Weft on Properties of Finished Stretch Woven Fabric

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Abstract

The stretch woven fabrics containing cotton/spandex core spun yarns are assumed to have improved wearing comfort and appearance owing to the properties of stretch, recovery and thus shape retention. Spandex present in the core of core spun yarn is the most essential performer behind these properties. So, here an attempt is made to study the influence of changing number of spandex weft core spun yarn on the various properties of stretch woven fabrics. The sole objective of this experiment is to study the influence of alternating spandex weft instead of regular spandex weft on the different stretch, shrinkage and mechanical properties of stretch woven fabrics.

Keywords: Spandex ratio, stretch properties, shrinkage, alternate spandex weft, fabric hand.

1. Introduction

The use of elastic yarns in woven fabrics has increased in present times because of the increased level of wearing comfort and looks of the garment. To achieve these performance properties in the clothing, stretchability plays an important role. To impart stretchability to the yarns, elastomeric fibres like lycra/spandex are incorporated in them. Core-spun yarns having elastane filament at the core and wrapped cotton fibres are commonly used in the weaving process [1]. Due to this gradual increase in demand of stretch woven fabrics by customers and manufacturer, many researchers have done studies on core spun yarns investigating the effect of a number of factors on which various properties of core spun stretch yarns and hence woven stretch fabrics depend.

Maqsood et al. have studied the effect of elastane linear density, thread density and weave float on the stretch, recovery and compression properties of bi-stretch woven fabrics, and it was observed that the elastic recovery was highly influenced by elastane count (higher elastane count resulted in higher recovery) whereas the fabric contraction was influenced by thread density and float size [2]. Gorjanc D S et al. carried out research to study the effect of changing constructional parameters like weave and thread density on deformability of conventional cotton and elastic cotton/elastane fabrics. The results showed that the breaking extension of fabric increases as the amount of elastane incorporation increases. However, increase in thread density has insignificant influence on breaking. The samples woven with twill weave show more deformation compared to plain weave [3].

Mathur K et al made an attempt to find how fabric stretch properties vary for change in its constructional parameters. The results of experiment indicate a higher stretch potential in weft direction compared to warp direction. It was also concluded that there is an insignificant effect of spandex draw ratio during weaving on stretch potential [4]. Celik H I et al investigated how elastane draw ratio, weft density and weave structure of bi-stretch denim fabrics influence the air permeability of the fabric and concluded that no clear trend was shown by air permeability of the different weave fabrics with increasing elastane draw ratio [5]. Sawhney A P experimented that the parameters of fabric structure specially weave and thread densities influences the stretch and other properties of the bi-stretch fabrics. The experimental results showed that for a given construction an open weave fabric offers higher values of stretch than a tighter weave. An increase in thread density in the grey fabric reduces the elastic properties of the finished fabric [6].

Qadir B et al. studied the effect of elastane denier and draft ratio on physical and stretch properties of stretch woven fabrics having elastane yarn in weft and concluded that an increase in elastane percentage increases the tear strength and recovery percentage. However a decrease is observed in tensile strength of fabric. Thus, the higher denier elastane results in higher tear strength, stretchability and recovery after stretch but lowers tensile strength. Also with an increase in draw ratio; the fabric’s tensile strength and stretchability increases whereas the tear strength and recovery after stretch decreases [7].

El-Ghezal et al. performed experiments to study the effect of finishing process and the elastane’s percentage on the mechanical and elastic properties of stretch denim. The samples were developed having fixed twist factor and various elastane's percentage. The results revealed that, elongation at break showed a decreasing trend with [8].

Thus, in this paper we study the effect of the spandex ratio on the mechanical and stretch properties of finished stretch woven fabrics.

Ertas et al. reported that the effect of using dual-core weft is parallel to the effect of using single core weft thread. Finally it was stated that fabric construction in terms of weft density greatly affects the fabric width instead of elastane ratio [9].

Except one or two, the most researches are based on the varying elastane percentage of spandex or elastane in fabric by means of changing number of spandex weft. Here arises the need to study the influence of varying spandex percent in yarn itself on the stretch woven fabric properties.

2. Materials and Methods:

2.1 Materials

In this study, woven fabrics were prepared in a weaving mill under controlled manufacturing conditions. Two 3/1 Z twill structured stretch woven fabrics were prepared with different ratio of spandex in weft. One sample contain all regular spandex weft of 12/1 Ne cotton/spandex core spun yarn containing 70 denier spandex filament. Another sample was prepared with alternating one spandex and one without spandex weft of same count. For warp, 10/1 Ne conventional 100% cotton yarns with thread density of 64 yarns/inch were used. The weft thread density used was 54 yarns/inch. Both the samples were woven on Airjet looms with keeping same rpm, reed and reed space. Samples of 100 meters foe each fabric types were produced. The fabric codes with description are listed in table 1 below:

Table 1 Fabric codes with description

Sr. No.	**Fabric code**	**Description**
1	RS	Sample with all regular spandex weft
2	AS	Sample with alternating spandex weft

2.2 Process sequence

The grey fabrics were processed according to the following processing route with the standard process parameters used for commercial production

Grey fabric → Grey wash → Pretreatment → Mercerisation → Peach → Wash → Dry pad → Pad steam → Finish→ Dry

2.3 Testing

In the present study, the fabric samples with different spandex ratios were tested for important mechanical and performance properties viz., fabric count, fabric width, fabric boil-off & residual shrinkage and functional properties of fabric such as tensile strength, tear strength, fabric crease recovery, fabric wrinkle recovery and drape. Stretch properties of fabric including elongation, growth and recovery were also evaluated. These tests were carried out after each processing stage. So, the effect of both the finishing process and the spandex ratio on the fabric properties may be revealed at once.

For an apparel fabric, 'hand' is considered as a most convenient and reliable parameter to judge the quality and performance of fabric for a particular end use. Therefore, finished stretch woven fabrics with different spandex percentage were investigated by using the KES-FB (Kawabata Evaluation System for Fabric). Kawabata Evaluation System (KES) equipment enables the evaluation of fabric hand value through automatic integration of mechanical properties at low stress. KES system consists of four different modules for different testing e.g. KES-FB1for tensile and shear tests, KES-FB2 for bending tests, KES-FB3 for compression properties testing and KES-FB4 for testing surface properties. Total 16 parameters describing fabric mechanical properties were obtained from the instrumental measurements. The 'primary hand values' pertaining to specific comfort aspects of the fabric and then 'total hand value' were calculated by the software using Kawabata equation.

Finished Fabric samples were tested according to the below mentioned standard test methods (Table 2). An average of 3 observations was taken for each sample.

Table 2 Test standards for fabric properties evaluation

Parameters	Unit of measurement	Test method
Conditioning	-	ASTM D 1776
Finish EPI & PPI	-	ASTM D 3775-2003
Finish width	Cm	ASTM D 3774-96
Weight	g/sq.m	ASTM D 3776-2002
Shrinkage (Warp & Weft)	%	AATCC-135
Tear strength (Warp & Weft)	N	ASTM D-1424
Tensile strength (Warp & Weft)	N	ASTM D-5034
Elongation (initial % A/F 3 wash)	%	ASTM D-3107-07
Growth (initial % A/F 3 wash)	%	ASTM D-3107-07
Crease recovery angle	Degrees	AATCC-66-2014
Wrinkle recovery	-	AATCC-128 (Appearance method)
Drape	%	Cusik Drapemeter
Hand	THV	Kawabata Evaluation System

3. Results and Discussion

3.1 Effect of different spandex ratio on dimensional properties of stretch fabrics

The woven stretch fabric samples with different spandex ratios were evaluated for thread count (EPI, PPI), fabric weight, Width, and Shrinkage. The results were drafted and represented as line charts and shown in Figure1-6.

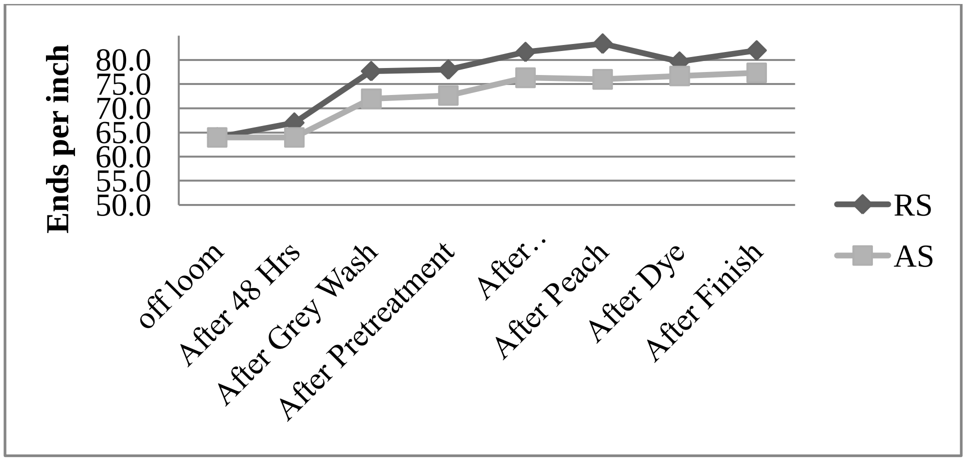

Figure 1 Effect of different spandex ratio on ends per inch (EPI)

Figure 1 shows an overall increase in warp density of stretch woven fabric containing cotton/spandex core spun yarn in weft after wet processing and finishing. During processing, the fibres contained in yarn tend to relax and finally get stable in a new position with lower energy level. This results in a change and in most cases an increase in thread density. This increment in number of yarns in unit length of fabric is reported more prominent in case of fabrics with elastane [10,11]. As far as the effect of spandex ratio in weft yarn is concerned, the higher warp density can be observed in fabrics with regular spandex weft yarn. This may be attributed to the increased amount of retraction forces in weft direction due to all regular spandex wefts.

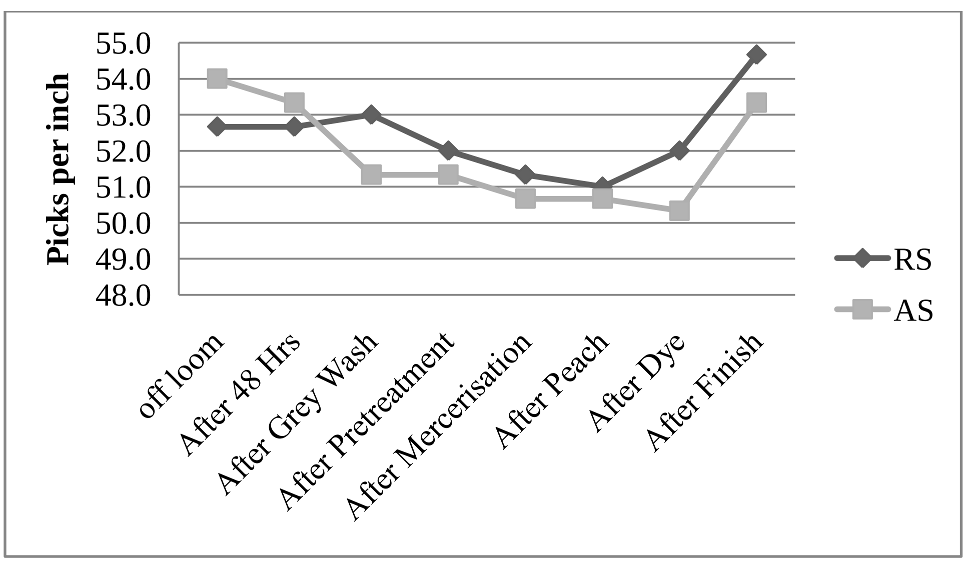

Figure 2 Effect of different spandex ratio on picks per inch (PPI)

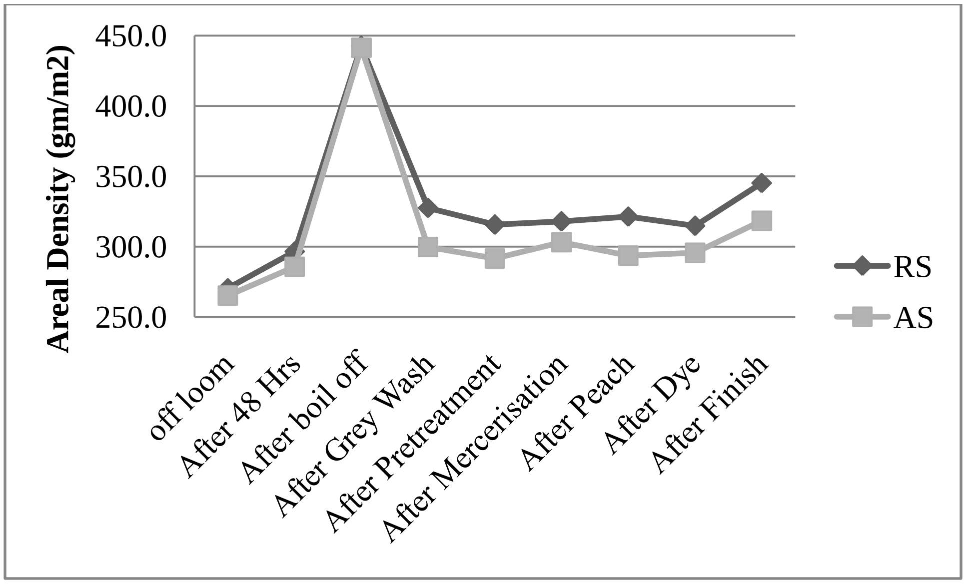

Figure 3 Effect of different spandex ratio on Areal Density (gsm)

Figure 2 indicates an increased number of picks per inch for regular spandex weft. The possible reason may be the increased width wise contraction that results in warp yarns to come closer to each other thus increasing the frictional force between warp yarns, resulting in progressive shrinkage in the warp direction [12].

The effect of increase in spandex core spun weft yarns on fabric areal density (gsm) is shown in figure 3. The increased areal density (gsm) of the final finished fabrics with regular spandex weft can be seen and may be attributed to increasing spandex amount weft direction. The literature advocates the generation of higher retraction force by higher amount of spandex in weft direction [7].

Figure 4 shows a decreased fabric width due to increasing no of spandex weft yarn. The reason may be the fact that weft yarns crimp exerts a tension on the yarn in weft direction. This results in the fabric contraction in width. This behavior is more prominent in case of stretch fabrics containing spandex. The effect is further enhanced with the increasing amount of spandex in weft yarn results in reduction in width [13].

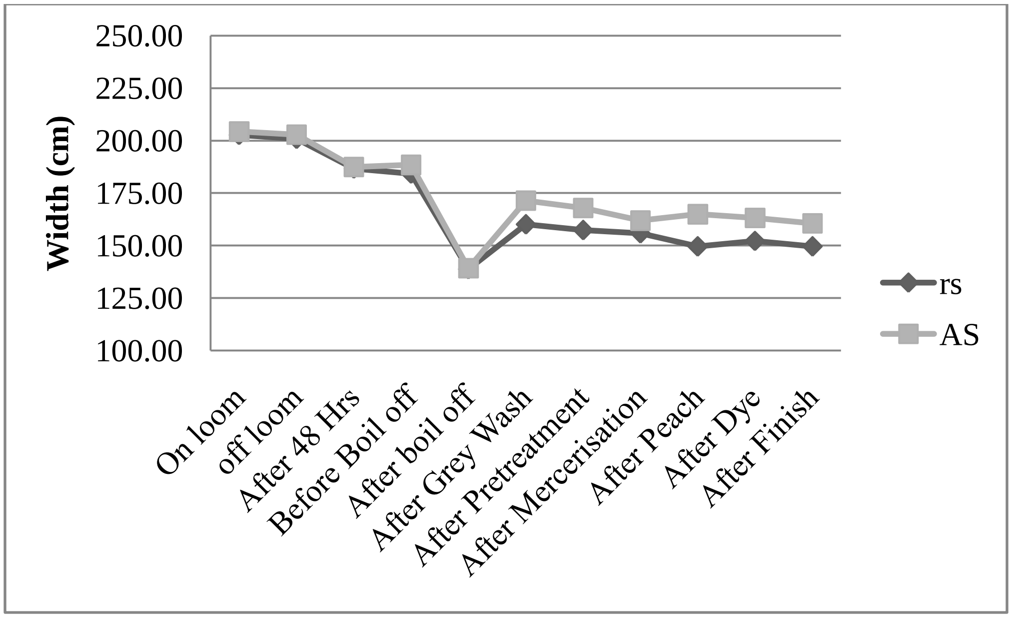

Figure 4 Effect of different spandex ratio on width

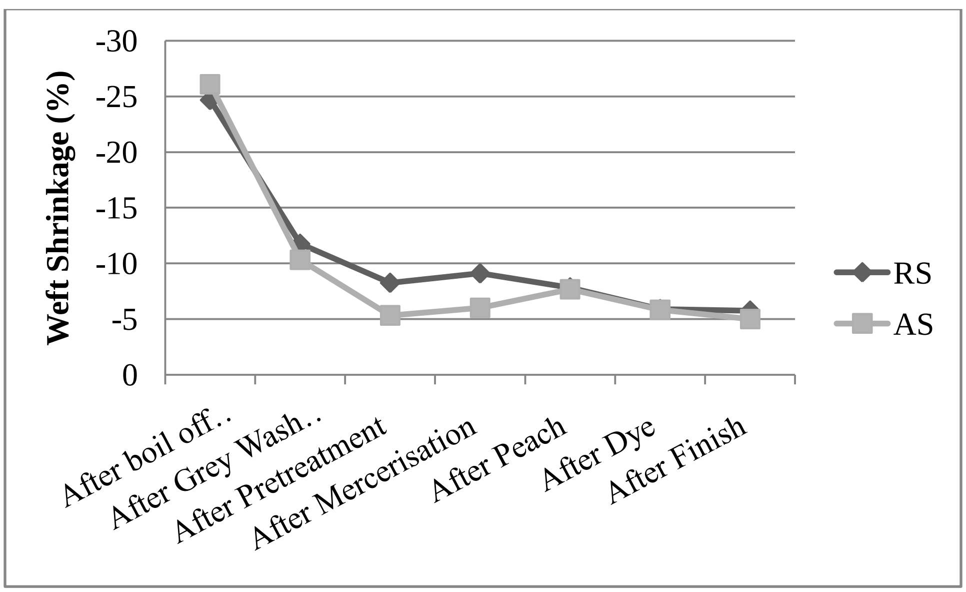

Figure 5 Effect of different spandex ratio on weft shrinkage

Figure 5 and 6 depicts the shrinkage behavior of stretch fabrics weft wise and warp wise respectively. There is an overall reduction in shrinkage percentage in both the samples due to processes of pretreatment, dyeing and final finish. In stretch fabrics with spandex only in weft direction, wet treatment results in remarkable width shrinkage due to release of temporary tension in yarns [13,14]. After finish, a no significant change can be observed in the weft shrinkage value as an effect of changing spandex ratio in weft yarn.

Shrinkage is observed in warp direction also but lesser than weft direction. There can be seen a gradual decrease in warp shrinkage from grey fabric to final finish. The possible reason for initial shrinkage is the relaxation of temporary tensions in the yarn on encounter with water during processing. Previous studies found that the increasing spandex amount results in an increase in relaxation shrinkage width wise. Due to this width wise shrinkage, the warp yarns come closer to each other thus increasing the frictional force between warp yarns, resulting in progressive shrinkage in the warp direction [12]. The more prominent effect can be seen in sample with regular spandex weft yarns.

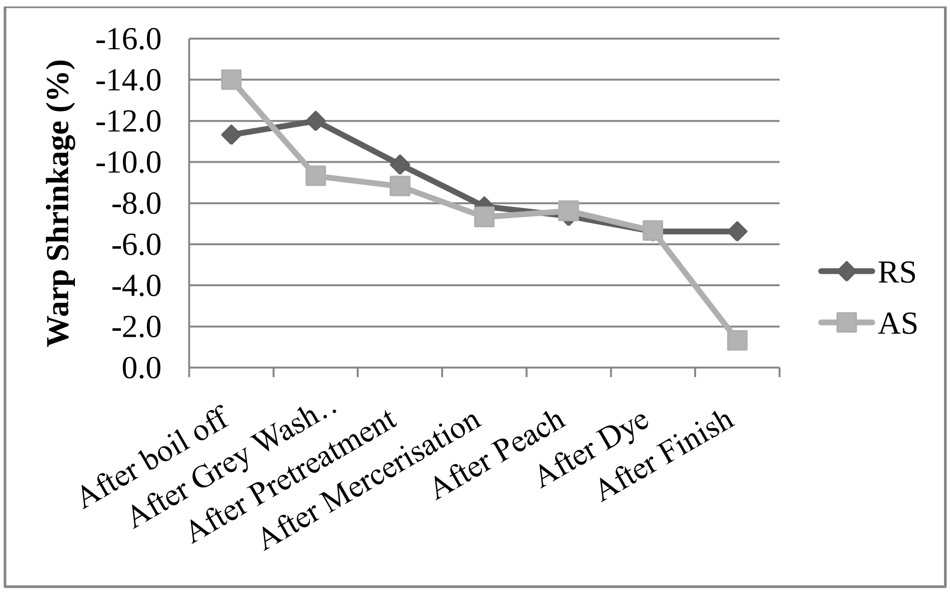

Figure 6 Effect of different spandex ratio on warp shrinkage

3.2 Effect of different spandex ratio on stretch properties of stretch fabrics

Elongation and growth are the properties of prime importance for a fabric in view of the comfortable wearing and good aesthetics provided by that fabric in a garment. These properties even become more critical in case of woven stretch fabrics containing spandex. In such fabrics, stretch or extension comes from the inherent property of spandex filament to extend up to 300 to 700%. The limit of this extensibility is dictated by the amount of spandex incorporated in the fabric [15]. The previous researches advocates the fact that fabric stretch-ability increases by increasing amount of spandex. This behavior can be attributed to the generation of higher retraction force by higher amount of spandex in weft direction. This results in off loom fabric contraction along the weft direction. Among stretchable fabrics, a fabric having higher contraction is considered more stretchable than that having less contraction [7].

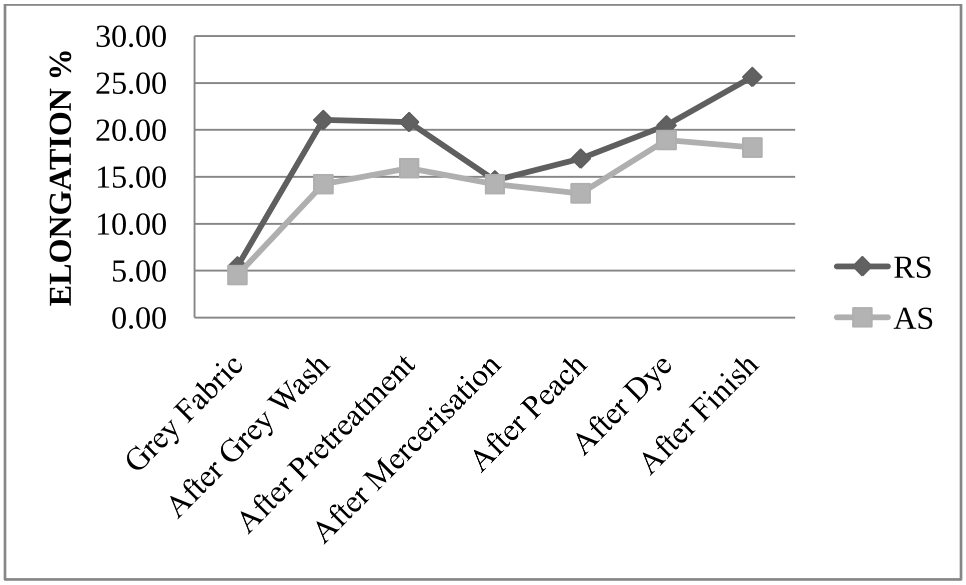

Figure 7 Effect of different spandex ratio on elongation

In present study also, the fabric containing higher amount of spandex in weft yarns makes the fabric more contracted in width due to more retraction forces and hence results in a higher elongation % respectively. In case of growth %, a negative relation between spandex rate and fabric growth was detected assuring that sample with regular spandex weft shows lesser growth than sample with alternating spandex weft yarn. The reason being the spring like behavior of spandex filament that exerts force on yarn to return to its original dimensions after stretching [13]. This effect will be more prominent in sample with more amount of spandex in weft and hence lesser growth %. The findings of elongation and growth are depicted in figure 7 and 8 respectively.

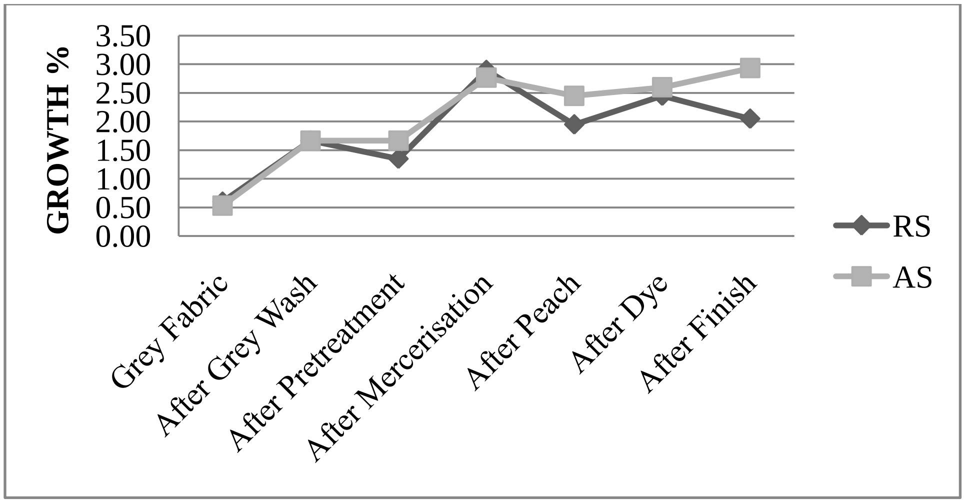

Figure 8 Effect of different spandex ratio on Growth

3.3 Effect of different spandex ratio on mechanical properties of stretch fabrics

Tensile strength is an important parameter of a fabric that dictates its durability and quality. In case of stretch woven fabrics, many researchers established a negative relationship between tensile and amount of spandex or elastane in weft direction of fabric [7,8,10,16,17]. In Figure 9, the result outcomes of tensile properties have been represented after mercerization and final finish. In contrary to the above mentioned researches, the results of the present study show an increase in tensile strength in weft direction with increasing spandex amount in weft direction of fabric [9,12]. The reason behind this behavior may possibly be the increase in areal density a result of progressive shrinkage in the fabric from grey state up to finishing. As fabric weight increases, the breaking strength increases in the fabric [17].

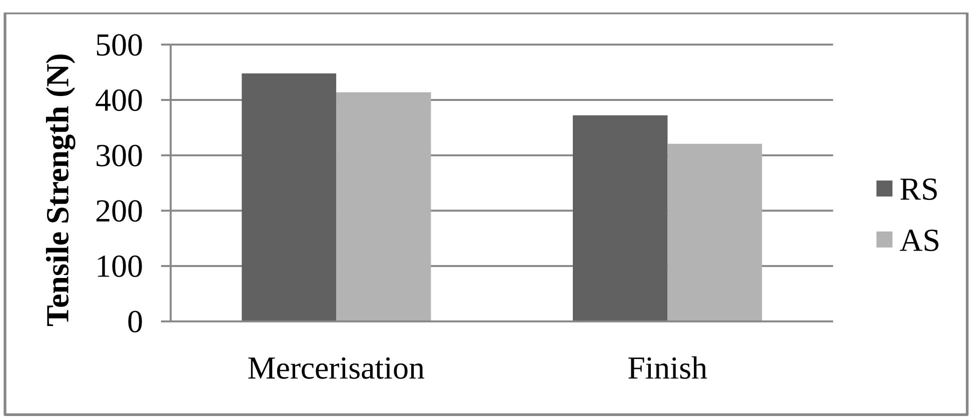

Figure 5 Effect of different spandex ratio on tensile strength (warp and weft wise)

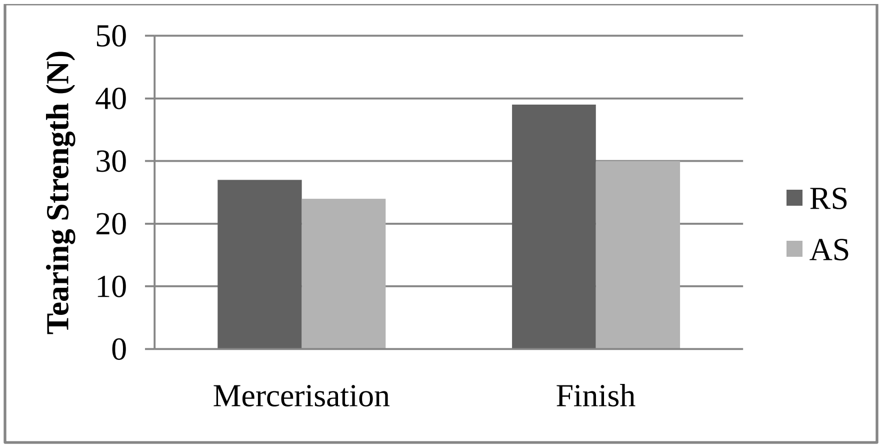

Figure 6 Effect of different spandex ratio on tearing strength (warp and weft wise)

Similar to tensile, tear strength of fabric also contributes to the total useable life and quality of a fabric. Technically, the tearing strength is the amount of ease with which yarns perpendicular to tearing force can be torn apart by the tearing force. During this the yarn slippage occurs in the fabric resulting in the closeness of yarns at tear point to resist tearing. This yarn slippage is reported to be better in case of fabrics woven with higher amount of spandex percentage. Hence, fabric with higher spandex denier should possess higher values of tearing strength [7]. As shown in figure 10, the experiment outcomes show a similar trend in tear strength in weft direction as discussed above.

3.4 Effect of different spandex ratio on aesthetic properties of stretch fabrics

The Figure 11 shows the crease recovery angle for weft directions after mercerization and final finish for two object samples. The results show higher crease recovery angle for samples having more spandex amount in weft direction. The results are obvious as the increasing amount of spandex filament keeping final yarn count same makes the yarn softer and flexible. Also the final finished sample exhibits higher crease recovery angle than mercerized. The possible reason may be the increased contraction of the fabric results in the compact arrangement of yarns to resist bending.

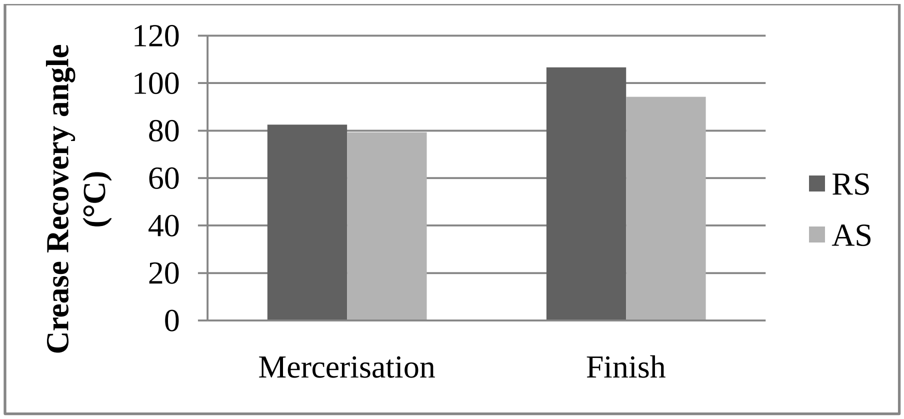

Figure 7 Effect of different spandex ratio on crease recovery angle (weft wise)

Fabrics may get wrinkled during wearing and handling during laundering, tumble drying etc. The recovery from these wrinkles is one of the desirable characteristic of fabric as far as aesthetics appearance of the garment is concerned. As per previous researches, the wrinkle recovery majorly depends upon the fabric construction and fibre content. In case of spandex as fibre content, it has relatively good wrinkle recovery [12]. In present study, the sample with higher number of spandex weft showed relatively better behavior for wrinkle recovery. The result outcomes of Wrinkle recovery test and Drape are shown in Table 3. As drape is the deformation in freely hanging fabric under gravitational force, it is in a strong positive relationship with fabric weight. In present experiment, the increasing spandex amount in samples makes the fabric more compact and hence heavier. Thus the value of drape coefficient showed a higher value for sample with all spandex wefts.

Table 3 Test results for wrinkle recovery and drape

Code	**Wrinkle Recovery**			**Drape**
	(Observer)			Average
	A	B	C	
RS	2	2	3	78.73
	2	2	3	
	3	3	3	
AS	2	2	2	60.73
	2	2	3	
	2	2	2	

3.5 Effect of different spandex ratio on hand behavior of stretch fabrics

Figure 12 shows the results of KES evaluation of the two object samples in view of the summer and winter suiting applications. The THV values indicate a decreasing trend with decreasing spandex amount in fabric. Both samples exhibit very low values of THV for summers and hence found unsuitable for summer suiting and fits well for winters (as shown by their Total Hand Values). s

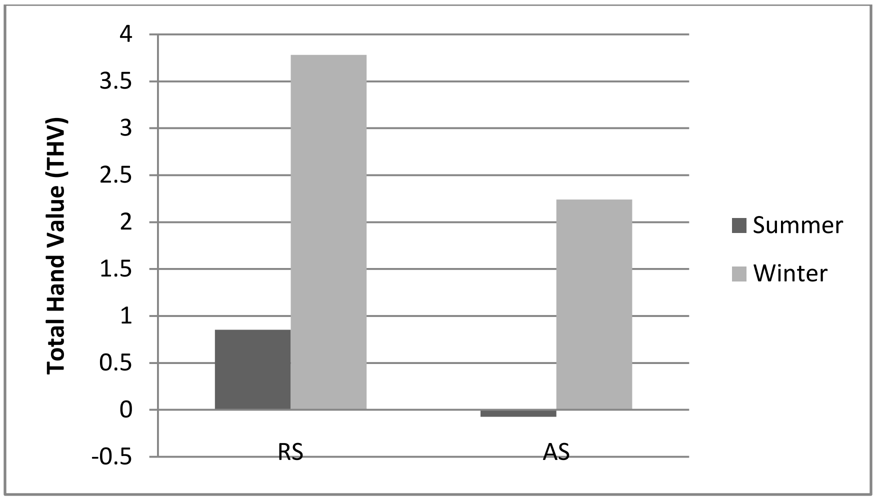

Figure 12 Results of KES testing

4. Conclusions

The focus with this study was directed to the influence of changing number of spandex weft in fabric on its dimensional, stretch, aesthetic and mechanical properties and even handle. The outcomes of the tests explicitly revealed that as the amount of spandex increases in weft direction, total spandex percentage of fabric increases. More retraction forces act in width wise direction resulting in more fabric contraction. This ultimately results in increased thread density, increased areal density and a reduction in fabric width. As more fabric contracts in width, its stretch potential increases and growth % decreases in this direction. An increment in weft shrinkage, tensile and tear strength was also observed. The sample with regular spandex also reveled better results for aesthetic properties. In case of fabric hand values, the fabric with higher spandex amount shows a higher THV for summer and winters. Samples exhibit very low THV for summers and hence found unsuitable for summer suiting and fits well for winters applications.

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