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FLEXURAL PROPERTIES OF CORE SPUN COTTON/SPANDEX SINGLE JERSEY FABRICS UNDER WASHING TREATMENTS

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INTRODUCTION

Fabric structure influence its basic proprieties, for example *appearance, smoothness, permeability, wrinkle, drape,* etc. Drape of fabrics, which is a very important aspect in apparel designing and fashion of garments, is influenced by its *flexural rigidity* of fabrics. Flexural rigidity is defined as the force couple required to bend a non-rigid structure. Thus, flexural rigidity may also be an important requirement for industrial fabrics to be used widely in heavy duty applications such as *geotextiles* (Fridrichova *et.al.*(2005)).

Stiffness is one of the most widely used parameters to judge flexural rigidity and fabric handling. Fabric stiffness and handling is an important decision factor for the end users. The degree of fabric stiffness is related to its properties such as fiber material, yarn and fabric structure (Fridrichova *et.al.*(2005), Hamilton and Postle (1974) and Mehmet (2003)). Thus, its' flexural properties can also be varied due to the greater structural changes that occurred during relaxation and washing treatments (Herath (2008) and Mehmet *et.al.* (2008)). Variations of flexural properties of *core spun cotton/spandex single jersey fabrics* under washing treatments are discussed in this paper. Results are also compared with same fabrics made from 100% *cotton.*

METHODOLOGY

Single jersey knitted fabrics made from core spun Cotton/spandex (*CO/SP*) -93%:7%- and 100% cotton (*CO*) were used for this research. Measured yarn counts are 20.40tex and 20.14tex for core spun CO/SP and 100% CO yarns. Fabric Samples were knitted according to the specifications given in Table 1. Based on that the fabrics were categorized into three *tightness factors* (*TF*) such as *L-TF* (for 2.90 mm stitch length), *M-TF* (for 2.70mm stitch length) and *H-TF* (for 2.50mm stitch length). In the Table1, machine off stitch lengths are given in parenthesis. It shows that CO/SP structures had higher stitch length reductions compared to 100% CO structures, even though they were knitted with the same stitch lengths. This may be the result of higher *robin back effect* and due to excellent stretch and recovery property of CO/SP core spun yarns. Machine off stitch lengths have been calculated under 95% significant level. Thus, the knitting specifications for single jersey CO/SP and CO structures are given in Table 2.

Material	Low fabric tightness [L-TF] stitch length (cm)	Medium fabric tightness [L-TF] stitch length (cm)	High fabric tightness [L-TF] stitch length (cm)
CO/SP	0.290 (0.268±0.020)	0.270 (0.255±0.012)	0.250 (0.240±0.010)
CO	0.290 (0.284±0.021)	0.270 (0.262±0.032)	0.250 (0.242±0.041)

Table 1: Machine set and machine off stitch lengths

Material	Machine diameter (inches)	Gauge	Machine RPM	No. of positive feeders	No. of needles
CO/SP	30	28	22	72	2640
CO	30	28	22	72	2640

Table 2: Knitting specifications

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Six samples were cut in size of 200 x 200 mm from each tightness factor of CO/SP and 100% CO fabrics in each wale direction and course direction and subjected to *dry-, wet- and full-relaxation* treatments according to ASTM D 1284-76 and *washing treatments* till 5th washing cycle according to ISO 6330.

Stiffness test was carried out according to the ASTM-D 1388-96 standards and bending length of knitted samples were measured in course and wale directions, after subjecting the samples to the treatments. For this test, samples in size of 200×25mm were cut from the wash treated and conditioned fabric samples. Five bending length measurements taken from each wale and course direction of a sample and all together 30 data were collected for each direction.

Flexural rigidity (G) of samples was calculated according to the following formula as per ASTM D 1388-96 standards.

Flexural rigidity (mg.cm)=G= $0.1MC^3$ - (1);

where M: mass /unit area of the fabric in g/m^2 measured according to the ASTM D 3776-95 and C: bending length in cm.

RESULTS AND DISCUSSION

Fabric area density variations:
According to the formula (1), fabric area density is one of the main influential factors for the flexural rigidity of fabrics and it significantly affect on bending length as well as stiffness properties of fabrics.

Figure 1 shows the area density variations of core spun CO/SP and 100% CO samples with different TFs. In Figure 1, W-1 to W-5 means the 1st washing cycle to 5th cycle, where we have taken the measurements. It shows that CO/SP gave the significantly higher area densities than 100% CO samples at all treatment stages , even though they have the same knitting parameters and yarn parameters. Reason would be the higher wale- and course- densities resulted at each treatment stage due to excellent stretch recovery property of core spun CO/SP yarns, better relaxation of CO/SP single jersey structures and the higher robin back effect imposed on CO/SP single jersey structures during knitting.

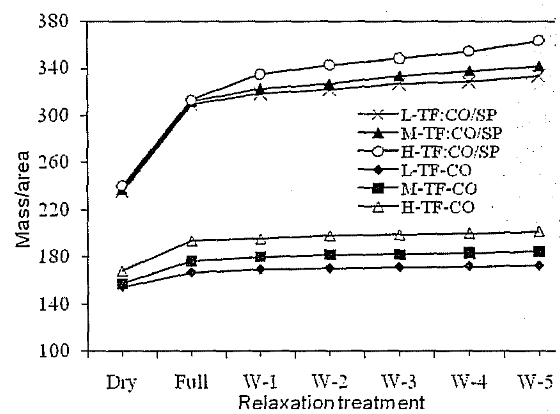

Figure 1: Area density (g/m^2) variations of CO/SP and CO Fabrics under treatments

In both graphs, greater increase of area densities can be observed during dry relaxation to full relaxation, but, after that, it gave the lower increase during washing treatments in the case of CO/SP fabrics. CO fabrics show the minimal increase compared to CO/SP in the washing treatments. Thus, area density is also proportionate to the tightness factor, in other words inversely proportionate to the stitch length.

Bending length variations

Figure 2 and 3 show the bending length variations of tested samples in wale (W) and course (C) directions. Higher bending lengths reported by CO/SP samples at all treatment stages compared to 100% CO fabric samples.

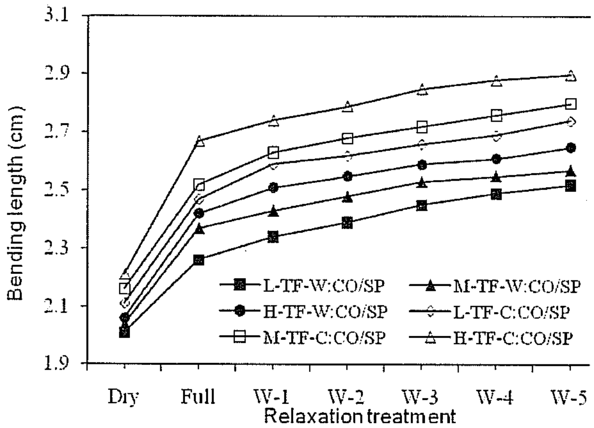

Figure 2: Bending lengths in wale and course directions of CO/SP fabrics

It means that CO/SP single jersey fabrics have higher stiffness than that of CO fabrics.
Reason could be its higher wale and course densities at each treatment stage, which increases stiffness of the structure as they increase the restrictions to yarn movements and yarn compressional force. This argument is confirmed by the conclusion made by Hamilton and Postle (1974).

Thus, another reason would the higher stiffness of core spun CO/SP yarns due to its straight filament core of spandex. Hence, higher thicknesses shown by CO/SP may also give an influence for higher stiffness of CO/SP single jersey fabrics.

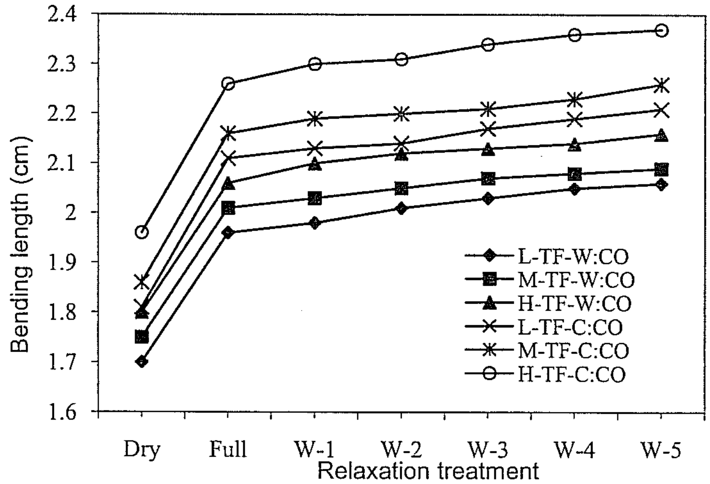

Figure 3: Bending length in wale and course directions of CO fabrics

Thus, An another remarkable feature shown in figure 2 and 3 is that higher bending lengths have given in course direction rather than in wale direction in CO/SP and CO single jersey fabrics, which agrees with some other research reports such as Hamilton and Postle (1974) and Mehmet (2008). Reasons could be the higher course densities of CO/SP single jersey fabrics compared to wale densities, which has been reported in the conclusion made by Herath (2008), and they can give higher restrictions to yarn movements and also impose higher yarn compressional forces. Figure 2 and 3 show the higher bending lengths with the structures having higher tightness factors. In other words, fabric stiffness have given the positive correlation with the fabric tightness factor. Reason may be as same as described previously.

Flexural rigidity values were calculated using data obtained for mass/area and bending lengths as given in formula 1. According to Figures 1 to 3, the behavioral patterns of CO/SP and CO structures are same. Therefore, we observed the same pattern in flexural rigidity variations in course and wale directions of both CO/SP and CO single jersey structures such as significantly higher flexural rigidities in CO/SP structures compared to CO fabrics and higher flexural rigidities in course direction than that of in wale direction. Thus, it was observed that flexural rigidity positively correlates with the fabric tightness for both CO/SP and CO fabrics.

CONCLUSIONS

Fabric flexural properties mainly depend on area density and bending length of fabrics. Higher fabric area densities gave by CO/SP fabrics at all relaxation stages than CO samples and it increased with progressing with treatments. Area density is also positively correlate with the fabric tightness factor. Greater increase of area densities reported from dry relaxation to full relaxation. Higher bending lengths have given by CO/SP structures than CO structures and it has progressively increased with the treatments. It can be said that stiffness in course direction is higher than that of wale direction in both CO/SP and CO fabrics. Bending lengths showed a positive correlation with the fabric tightness factor. Increasing rate of flexural rigidity values in CO/SP fabrics are higher than that of CO fabrics during the progression of treatments. Higher flexural rigidities are given in coarse direction than that of in wale direction. Flexural rigidity is positively correlated to fabric tightness factor for CO/SP and CO single jersey fabrics.

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