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FTT comfort indices of ring-spun and air-jet knitted fabrics with post-treatments

S Vasile¹, B Malengier², A De Raeve¹ and A Binti Haji Musa²

¹University College Gent, Faculty of Science and Technology, Department of Fashion, Textiles and Wood Technology/ FTI Lab, Buchtstraat 11, 9051 Gent, Belgium

²Centre for Textile Science and Engineering, Department of Materials, Textiles and Chemical Engineering, Technologiepark 907, 9052 Zwijnaarde (Gent), Belgium

Email: simona.vasile@hogent.be

Abstract. The Fabric Touch Tester (FTT) is a relatively new instrument that simultaneously measures several fabric indices and subsequently compute from them primary and global comfort indices (fabric total touch and total feel). The main aim of this research was to investigate the ability of the FTT to discriminate between primary comfort indices of fabrics differentiated by yarn type (i.e. ring-spun yarns and air-jet yarns) and finishing treatments.

Polyester-cotton knitted fabrics were produced and their FTT-predicted primary comfort indices (i.e. smoothness, softness and warmth) were compared with those of the finished knits (i.e. dyed and dyed with softening treatments). For the considered fabrics, it was found that the type of yarn did not lead to statistically significant different comfort indices. Nevertheless, significant differences were found between the comfort indices of the untreated fabrics and the fabrics dyed and treated with a softener regardless the type of yarn. The findings are in line with similar findings from literature where other instruments were used. These first results suggest that FTT is a promising tool that is able to distinguish between samples with small differences induced by finishing treatments.

1. Introduction

Hand-related properties of fabrics have been extensively investigated [1] by both subjective and objective methods. The objective methods (i.e. KES-F, SiroFAST, PhabrOmeter®, Handle-O-Meter, etc.) characterize the fabric hand indirectly by measuring certain mechanical fabric parameters. Subjective methods (e.g. panel of experts) are used to assess fabric tactile comfort properties (i.e. smoothness, softness, etc.) and the results are correlated with those of the objective methods. The Fabric Touch Tester (FTT) [2] is a relatively recent instrument which simultaneously measures thirteen physical fabric properties (i.e. bending, compression, friction, roughness and thermal properties) and uses them to predict some comfort indices amongst which softness, smoothness and warmth. Fabrics for clothing have been investigated by means of FTT [3] and satisfactory prediction models were found between the fabric indices and several tactile properties (i.e. smoothness, softness, prickliness, warmth and dampness) subjectively evaluated by a panel. Information about the mechanical design of the instrument, its reliability and repeatability was described elsewhere [4]. The authors have employed FTT [5] and found that this instrument could successfully discriminate between several protective clothing fabrics subjectively indistinguishable [6], as well as between fabrics containing various cellulosic fibers [7] or fabrics differentiated by small-changes in the production parameters.

Various studies about the effect of wet processing, chemical finishing, mechanical finishing and refurbishment on fabric hand are presented by Behery [1]. Shakyawar and Behera [8] also studied the influence of the softening treatments on hand value of woven fabrics produced from Indian wool and



their blends. A KES-F equipment was employed to assess hand-related mechanical properties of the fabrics and it was found that extensibility, tensile resilience and coefficient of friction significantly increased after softening treatments, whereas the bending and shear rigidities and their hysteresis and compressional resilience reduced. The fabrics treated with cationic and amino silicone softeners showed total hand value THV higher than those of untreated fabrics and the amino silicone softener was more effective than cationic softener. Yee [9] studied the effect of anti-wrinkle finishing on hand value of 100% light-weight cotton woven fabrics. Two instruments (i.e. KES-F and a PhabrOmeter) were used for assessment of fabric hand and the results were not in agreement: KES-F showed an improvement of hand after anti-wrinkle treatment and PhabrOmeter revealed a poor hand after treatment. Variation of the smoothness and softness after a treatment was also investigated in other studies [10, 11, 12]. Decrease of fabric warmth and an increase of its smoothness after repeated washing was also reported [13].

Variation of the fabric hand due to various finishing treatments can be detected by some testing equipment but the expert panels may have difficulties to catch it, when the difference is very small. Bernard [14] investigated the influence of various laundering methods on the hand of woven cotton fabrics assessed by a KES-F instrument and by a hand panel of 26 females. Treatments included washing methods using detergents and softeners, as well as after treatments with selected starch applications. The objective assessment showed significant differences between the treatments which were not detectable by the human subjects. Our previous studies [5] also indicated that the panels could correctly classify fabrics differentiated by 5-6 % detergent but they failed in catching low differences in detergent concentration (i.e. 1.5 %).

2. Aim of the research

FTT is a relatively new instrument for the assessment of fabric hand and the main FTT-related studies [3, 4] discussed the FTT fabric parameters and their correlation with the results of hand panels. In both studies, the predicted FTT comfort indices were not disserted and the influence of fabric finishes on FTT fabric parameters or comfort indices had never been investigated. Therefore, the main aim of this research was to investigate the ability of the FTT to discriminate between fabrics with different treatments.

The influence of dyeing and finishing on three fabric comfort indices predicted by FTT was studied. For this purpose raw knitted fabrics were produced and their FTT-predicted comfort indices (i.e. smoothness, softness and warmth) were compared with those of finished knits (i.e. dyed and dyed and finished with softeners). The fabrics were also differentiated by yarn type (i.e. ring-spun yarns and air-jet yarns) and the second aim of the research was to study the variation of the FTT comfort indices with the type of yarns used. The results were compared with the results from literature to assess the reliability of the FTT comfort indices.

3. Materials and methods

3.1 Materials

Polyester-cotton (40/60) ring-spun yarns (A) and air-jet yarns (B) Ne20, were used to produce knitted fabrics with similar structure and weight. The fabrics A and B were afterwards dyed (i.e. A1, B1) or dyed and treated with a softener (i.e. A2, B2). In total twenty specimens were used for each fabric quality of which ten were used to assess the face-side of the fabric and the rest for the back-side. No standards currently exist for the FTT, therefore the fabrics were tested according to the testing protocol of the equipment manufacturer. The specimens were conditioned prior testing for a period of 24 h, at $20\pm 2^\circ\text{C}$ and $65\% \pm 4\%$ relative humidity.

3.2 Fabric Touch tester FTT

Unlike other instruments, FTT is able to assess, during one test, several fabric physical indices (as displayed in Table 1) for the inside (I) and outside (O) of the fabric. Fabric indices (e.g. except

compression and thermal properties) are simultaneously measured in two fabric directions (e.g. wale and course) due to an L-form of the specimens. Details about the modules of the instrument and calculation of these indices are given elsewhere [3, 4]. The FTT fabric indices are subsequently used by the FTT software to predict three primary comfort indices (i.e. smoothness, softness, warmth) and two global comfort indices (i.e. total hand and total feel). These primary comfort indices are calculated based on statistical models developed by the FTT manufacturer after correlating the fabric indices with the comfort indices assessed by a hand panel. FTT distinguishes between active and passive comfort indices which refers to the sensation the fabric will give when assessed with the fingers and during wear respectively. These indices are also computed separately for the inside and the outside of the fabric. In this study the active FTT primary comfort indices are considered both for outside and inside of the fabrics.

Table 1. FTT fabric indices

Fabric Property	FTT Fabric Index	Description	Unit given by FTT software	SI unit
Bending	BAR	Bending Average Rigidity: force needed to bend per radian	gf mm/rad	N m rad ⁻¹
	BW	Bending Work: work needed to bend the specimen	gf mm rad	N m rad
Friction	SFC	Surface Friction Coefficient: friction coefficient on surface with ribbed metal plate	-	-
Roughness	SRA	Surface Roughness Amplitude: roughness irregular wave amplitude	μm	m
	SRW	Surface Roughness: Wavelength: roughness irregular wave wavelength	mm	m
Compression	CW	Compression Work: work needed to compress the specimen	gf mm	N m
	CRR	Compression Recovery Rate: percentage of thickness changes after compressed	-	-
	CAR	Compression Average Rigidity: forces needed to compress per mm	gf/mm ³	N m ⁻³
	RAR	Recovery Average Rigidity: forces reflected when recovery per mm	gf/mm ³	N m ⁻³
	T	Thickness: depth of the materials	mm	m
Thermal properties	TCC	Thermal conductivity when compression: energy transmitted per degree per mm when compresses the specimen	10 ⁻³ W/m C	W m ⁻¹ °C ⁻¹
	TCR	Thermal Conductivity when Recovery: energy transmitted per degree per mm when the specimen recovers	10 ⁻³ W/m C	W m ⁻¹ °C ⁻¹
	Qmax	Thermal Maximum Flux: maximum energy transmitted during compression	W/m ²	W m ⁻²

4. Results and discussion

The average values of the FTT softness, smoothness and warmth indices for the ring-spun knits A and air-jet yarns knits B are displayed in Figures 1 a-c both for inside and outside of the fabrics. Moreover the FTT indices of the dyed fabrics (A1, B1) and fabrics with softening treatments (A2, B2) are showed.

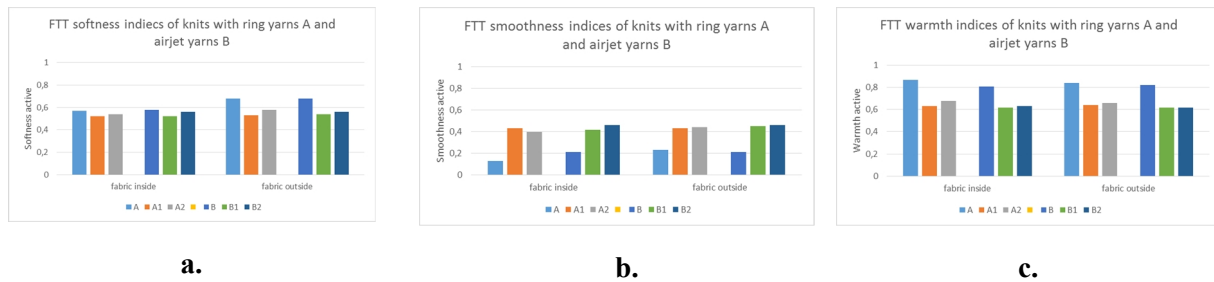


Figure 1. FTT indices softness (a), smoothness (b) and warmth (c)

4.1 Softness

FTT softness indices of the greige knits A with ring-spun yarns decreased after dyeing and again slightly increased after the treatment with a softener, as can be seen in Figure 1a. An Anova analysis ($\alpha=0.05$) was performed which showed that the differences were only significant for the outside of the fabrics ($p<0.05$). A post-hoc Tukey HSD test showed that the softness of the untreated knits A was significantly higher than the softness of the A1 and A2 knits, graphically indicated by bars that are not overlapping (Figure 2). A significant difference was also noticed between the softness of A1 and A2, with A2 being the softest. Similarly, the untreated knits B were significantly softer than the knits B1 and B2 but no significant difference was noticed between B1 and B2. Comparable values were found for the average FTT softness indices of untreated fabrics with ring-spun yarns A and air-jet yarns B.

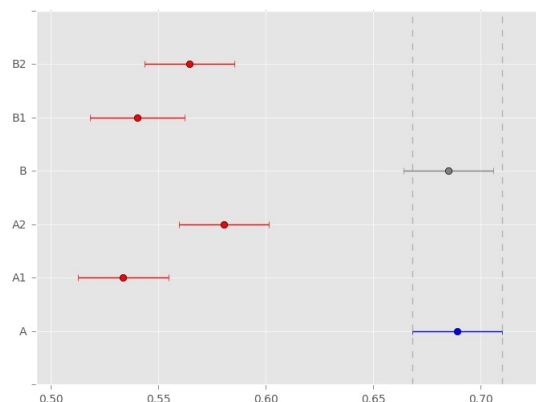


Figure 2 Statistical significant differences between the softness for outside of the fabrics

4.2 Smoothness

FTT smoothness indices of untreated knits A and B increased after dyeing as it can be seen in Figure 1b. Significant differences were noticed between the inside and outside of some samples (both $p<0.05$) but not between the smoothness of the dyed knits (A1/ B1) and finished knits (A2/ B2), as shown in Figure 3. The Tukey test however showed that the untreated knits A and B were significantly rougher than the dyed A1/B1 and finished knits A2/B2. Some differences were noticed between the average FTT smoothness indices of untreated fabrics A (0.13) and B (0.21) suggesting that air-jet yarns fabrics lead to slightly smoother fabrics, at the inside. These findings were not consistent for the fabric outside (0.23 for knit A versus 0.21 for knit B) and the Tukey test found no significant differences between the smoothness of the knits with air-jet yarns and ring-spun yarns, neither inside nor outside.

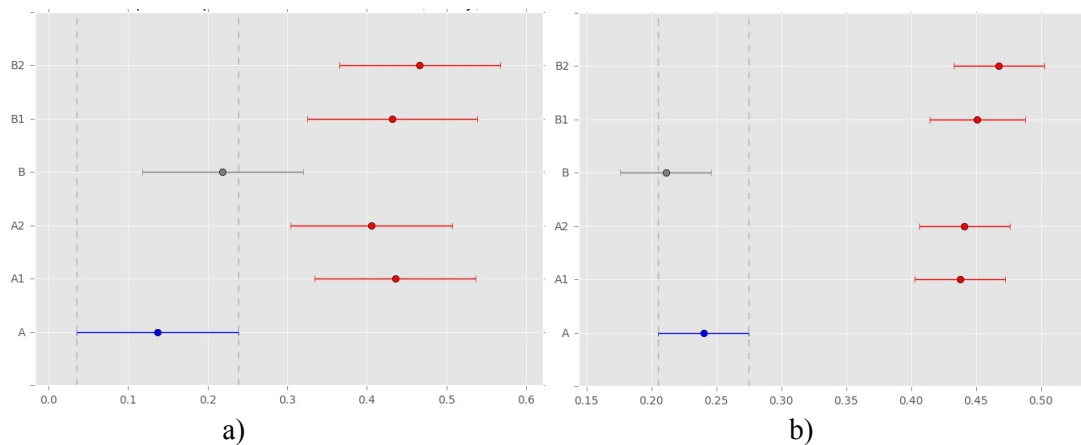


Figure 3 Statistical significant differences between the smoothness of the fabrics for inside (a) and outside (b)

4.3 Warmth

FTT warmth indices of greige knits A and B decreased after the applied treatments as shown in Figure 1c and this is in agreement with other studies [13] that reported a decrease of fabric warmth and an increase of its smoothness after repeated washing. The untreated knits A and B were significantly warmer than the dyed knits and the dyed knits treated with softener but the Tukey test found no significant differences between the warmth of two treated knits (A1/A2 and respectively B1/B2). The average *FTT warmth indices* of the (outside) greige fabrics with ring-spun yarns A was slightly higher (0.87) as compared with air-jet yarns B (0.81) and similar trends were found for the fabric outside (0.84 for knit A and 0.82 for knit B). Nevertheless, none of these differences were found statistically significant, as shown in Figure 4.

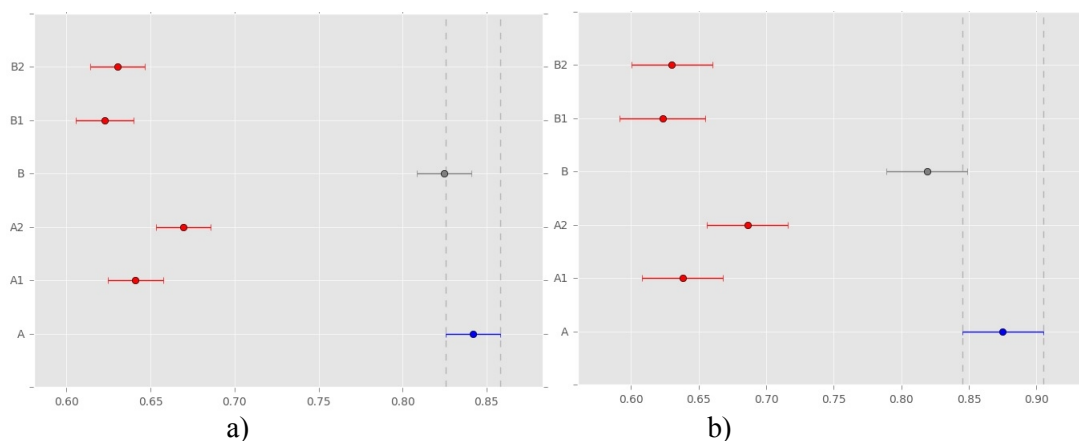


Figure 4 Statistical significant differences between the *FTT warmth indices* of the fabrics for inside (a) and outside (b)

5. Conclusions

The *FTT softness indices* of dyed fabrics A1 and B1 increased after the treatment with a softener, as expected. The increase of the *FTT smoothness indices* and decrease of *FTT softness indices* after a treatment (i.e. dyeing) is in line with similar findings in literature [8, 10-12]. The decrease of the fabric warmth after a finishing treatment (i.e. dyeing) is in line with another study [13] that reported a positive influence of repeated washing treatments (i.e. including a final wash with a softener) on the cool feeling of the fabric.

The type of yarn didn't lead to statistically significant different comfort indices. Nevertheless, the type of yarn seems to mostly affect the smoothness (i.e. air-jet yarns contributing to slightly smoother knits). This can be due to a lower hairiness of the airjet yarns as compared with ring-spun yarns [15] and could also explain the slightly warmer fabrics with ring-spun yarns.

The trends found suggest that the three FTT comfort indices are correct for this particular type of knits. Expert panels can be further employed to confirm the results. Based on our previous results [6] and results reported by Bernard [14], we expect that the panels will correctly distinguish between the knits A and B with ring-spun and air-jet yarns respectively and probably also between the untreated knits (A, B) and the knits treated with softener (A2, B2) respectively. We assume however that the panel will have difficulties in catching the very small differences between the comfort indices of the finished fabrics A1-A2 and B1-B2 respectively. These first results suggest that FTT is a promising tool that is able to distinguish between samples with small differences induced by finishing treatments.

Acknowledgments

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References

- [1] Behery H 2005 Effect of mechanical and physical properties on fabric hand, Woodhead Publishing Series in Textiles, Elsevier
- [2] <http://www.sdlatlas.com/product/478/FTT-Fabric-Touch-Tester>
- [3] Hu J Y, Hes L, Li Y, Yeung K W and Yao B G xxxx, Fabric Touch Tester: Integrated evaluation of thermal-mechanical sensory properties of polymeric materials. *Polymer Testing*, **25** (8), 1081–1090
- [4] Liao X, Li Y, Hu J, Wu X and Li Q xx A simultaneous measurement method to characterize touch properties of textile materials. *Fibers and Polymers*, **15** (7), 1548–1559
- [5] Touché: Boosting innovation through application of basic understanding on the process and testing of textile touch and fabric feel, CORNET project (2014-2016); <http://www.toucheproject.eu/>
- [6] Vasile S, Malengier B, De Raeve A, Louwagie M, Vanderhoeven M 2006, Assessment of sensorial comfort of fabrics for protective clothing, ECPC conference
- [7] Abou Rous M, 2016 Handle properties of fabrics made of wood-based fibers/ Softness and smoothness of textiles, Proceedings of Man-Made fibers congress MCF
- [8] Shakyawar D B, Behera B K 2009 Influence of softening treatments on hand value of woven fabrics produced from Indian wool and their blends, *Indian Journal of Fibre & Textile Research*, **34**: 76-81
- [9] Yee C.K 2012 The Effect of resin treatment on hand value of 100% light-weight cotton woven fabrics, BSc thesis, Institute of Textile and Clothing, the Hong Kong Polytechnic University
- [10] Zia K M et al., 2011 Preparation of rich handles soft cellulosic fabric using amino silicone based softener. Part-I: Surface smoothness and softness properties, *International Journal of Biological Macromolecules* **48**, 482–487
- [11] Ibrahim N A et al., 2010 Effect of Knit Structure and Finishing Treatments on Functional and Comfort Properties of Cotton Knitted Fabrics, *Journal of Industrial Textiles* **40**
- [12] Bereck A et al., 1997 A simple method for objective characterization of fabric softness. Part 1: influence of bleaching, dyeing and crosslinking wool, *JSC*, **113**, 322-326
- [13] Vivekanadan MV, Raj S, Sreenivasan S and Nachane R P, 2011 Parameters affecting warm-cool feeling in cotton denim fabrics, *Indian Journal of Fibers & Textile Research* **36**, 117-121

- [14] Bernard A B, 2009 Factors Affecting Human Comfort Response to Garments, MSc thesis , North Carolina State University
- [15] Ahmed S, et. al. 2015 Comparative study of ring, rotor and air-jet spun yarns, *European Scientific Journal*, **11**