KEER2010, PARIS | MARCH 2-4 2010
INTERNATIONAL CONFERENCE ON KANSEI ENGINEERING AND EMOTION RESEARCH 2010

INFLUENCE OF TEXTILE PARAMETERS AND AGEING ON CONSUMER BEHAVIOUR

Gaurav AGARWAL[*a,b], Ludovic KOEHL[a,b] and Anne PERWUELZ [a,b]

[a] *Univ Lille Nord de France, F-59000 Lille, France ;*
[b] *ENSAIT, GEMTEX, F-59100 Roubaix, France*

ABSTRACT

Textiles producers and designers need to decide on fabric parameters which can fulfil the consumer expectations. The textile consumer always has specific preferences. These preferences apply to the textile properties at the time of purchasing the textiles and also to the perception of how long lasting these properties will be. The gap between consumer behaviour and manufacturer thinking towards the textiles need to be bridged. We tried to study the influence of knitted textile material parameters on the sensory feeling of textiles. We have chosen the key textile parameters relevant to knitting i.e. Fibre type (Cellulosic or synthetic), Fibre fineness (Regular or micro fibre), Yarn Construction (Ring, Open end), Knitting Structure (Jersey, Rib or Interlock) in order to study their effect on the sensory feeling of textiles.Sensory Evaluation is performed by a panel of trained subjects (panellists) using a standard evaluation procedure. This allows the generation of a list of exhaustive sensory attributes describing fabric hand and appearance, and then the determination of relative or absolute scores for fabric samples for each sensory attribute. We also examined the change in handle of fabric with life cycle of the fabric. The change in handle of the fabric after washing is unavoidable because of strong mechanical action during washing. Principal component analysis (statistical data analysis which includes appropriate criteria) was then performed in order to make a better interpretation of the sensory data by plotting the fabric map and sensory attribute map. This work can be used as a tool for textile manufacturers to design the input parameters for knitted textiles: taking account of consumer behaviour for particular fabrics may allow the generation of better emotional response during the life cycle of apparel.

Keywords: *Sensory Evaluation, Textiles, Ageing, Principal Component Analysis*

---

* Corresponding author: Gaurav Agarwal
Ecole Nationale Supérieure des Arts et Industries Textiles, Roubaix (France)
2, allée Louise et victor Champier, 59056, Roubaix, France
gaurav4textile@gmail.com

1. INTRODUCTION

Touch handle of textiles is a prime concern for consumers, not only fresh fabric but also during the whole life cycle of the fabric. When a garment or fabric is purchased, the consumer always tries to select it on the basis of a personalised method of assessment chosen for a particular end use. This kind of assessment is called subjective evaluation of the fabric; the result of this kind of assessment is not the same for a fresh fabric and the fabric after certain use. The fabric's touch handle changes from its cradle to grave state. Machine laundering can leave fabrics with an uncomfortable hand as a result of the removal of the fatty finish and lubricating waxes from the fabric when synthetic detergents remove dirt and oil. As a result, after the introduction of synthetic detergents to the market, the need for a fabric softener was recognized.

Significant work has been already done to study the effect of laundering with and without softener on mechanical and thermal properties of fabrics [1-10] but still it has the limitation of not being able to describe the human perception regarding touch or handle of fabric. Of course to some extent the combination of a few mechanical parameters can together predict the main attributes of fabric hand. Sensory perception is complex and involves an individual's perceptive representation implying that an instrument approach may generally not be sufficient to simulate the richness of perception as a whole [11].

Sensory analysis is defined as the examination of sensory attributes by the sense organs, it is dived in two parts: discriminative tests and descriptive tests. Descriptive analysis methods involve the description of both qualitative and quantitative aspects of perceptions and require a highly trained panel. The development of an attribute list, description of the attributes and panel training are the crucial steps of descriptive sensory evaluation test [12]. Harada tried to describe different fabric attributes and translated these into ordinary terms used by the consumers [13]. The sensory study of textiles started long ago and is still continuing today not only by the consumers but also by textile production units for quality assessment.

It is important for the manufacture to decide on the textile parameters for a particular end use, taking into consideration the consumer behaviour towards the textile. This paper is aimed at the following studies-

i. An overview of the influence of different textile parameters for Knitted fabrics with respect to sensory attributes.
ii. Influence of ageing process on sensory hand.

2. EXPERIMENTAL

2.1. Fabric samples

It was important to select a group of fabric samples which can represent all fabric types used for garments. For knitted garments dimensional stability, pilling, deterioration of fabric handle and shape distortion, after laundering are perceived by consumers. This is a great concern. Softener producers claim to provide benefits in reducing these problems. Knitted fabric were therefore used in this study. On the apparel market, man-made fibres are used more and more (they represented 60% of the market) to the detriment of natural fibres

(40%). Polyester represents 70% of the synthetic fibres on the market. On the natural fibres market, cotton is by far the most used fibre. Synthetic fibres are hydrophobic whereas cellulosic ones are hydrophilic. They are very different from a chemical and morphological point of view, so they behave very differently with chemicals (softeners, washing powder…) and therefore they are expected to be different in terms of sensory perceptions and ageing behaviour. We chose polyester as it is the most used man-made fibre. We chose to work on Viscose; It is a cellulosic fibre, so it is quite close to the cotton in terms of behaviour. Viscose is a man-made fibre so it is possible to fully control the morphology and all the other yarn parameters. The different market relevant knitted fabrics were selected varying in knitted construction (Jersey, Rib and Interlock), and fibre type (micro or regular). One Open end, jersey Knitted fabric is also included to observe the effect of yarn construction on softener performance. In Table-1, details of the Knitted fabrics used in study are given.

Table 1: Knitted textile parameters.

Code	Fibre nature	Fibre	Yarn Count	gsm	Construction	Gauge
VμJ	100% Viscose (Modal)	Micro fibre	50 Nm	145	Jersey	28
VμR	100% Viscose (Modal)	Micro fibre	50 Nm	180	1x1 Rib	20
VμI	100% Viscose (Modal)	Micro fibre	50 Nm	240	Interlock	20
VRJ	100% Viscose (Ring)	Regular	50 Nm	160	Jersey	28
VRR	100% Viscose (Ring)	Regular	50 Nm	175	1x1 Rib	20
VRI	100% Viscose (Ring)	Regular	50 Nm	250	Interlock	20
VμOJ	100% Viscose (OE)	Micro fibre	50 Nm	150	Jersey	28
PμJ	100% Polyester	Micro fibre	60 Nm	130	Jersey	28
PμR	100% Polyester	Micro fibre	60 Nm	165	1x1 Rib	20
PμI	100% Polyester	Micro fibre	60 Nm	230	Interlock	20
PRJ	100% Polyester	Regular	60 Nm	172	Jersey	28
PRR	100% Polyester	Regular	60 Nm	200	1x1 Rib	20
PRI	100% Polyester	Regular	60 Nm	250	Interlock	20

The whole study requires running washing cycles in market relevant laundry conditions which had to be same throughout the study: same cycle, same softeners, same water hardness, same loading weight. All the washing experiments were done on following conditions:- a)Load: 1 Kg b)No prewashing c) washing product :45ml non-bio liquid detergent d) Fabric Conditioner: 35ml (Rinse cycle cationic conditioner e) 40oC Cotton cycle f) Water hardness: 250F g) Line dried. All the LCA (Life cycle assessment) study shows that the consumer use phase of the life cycle of a garment involved 30-50 washing cycles and AATC-28, ISO: 105-C05 also involved 30-50 washing cycles, hence we have chosen 40 wash cycles for this study.

2.2. Sensory Evaluation

About 50 terms have been generated by the panellists. Brainstorming sessions were conducted for generating appropriate descriptors. Among the most used there were: light, Supple?, flexible, thin, hairy, heavy, soft, thick, Relief ,with relief (due to the construction), elastic, cool, velvety, extensible, stretch, warm, compact, dense. After a round table discussion between the trained panellists on the meaning of the terms they used, the list of terms was reduced:

- The terms that were generated by one person only are removed.

- The terms with a similar meaning are merged.

- The opposite terms are associated with each other (for example, "thick") and "thin" are reduced into "Thickness" and a thick sample is scored with a high score for thickness, whereas a thin sample is scored low in thickness.

3.1. An overview of tactile properties of different Knitted fabrics with respect to sensory attributes

The first sensory evaluation session was aimed to provide an overview of the fabrics and the way to perceive the attributes. The panellists were presented with the 13 knitted fabrics (Table:1). We used relative scores for this study i.e. panellists were asked to evaluate the fabrics by ranking them from 1 to 13 with respect to each attributes. For sensory evaluation of these 13 knitted samples, pair comparison method was used, i.e. comparison of two samples with respect to particular attribute. Then each sample is ranked with respect to one of the samples that had been already compared. Panellists were asked to concentrate on the particular parameter being evaluated at the time. The procedure for evaluation of each attribute was explained in detail.

To analyse data, a correspondence analysis is run. As a PCA (Principal components analysis), this statistical analysis aims to reduce multidimensional data sets to lower dimensions for analysis with minimum loss of information.

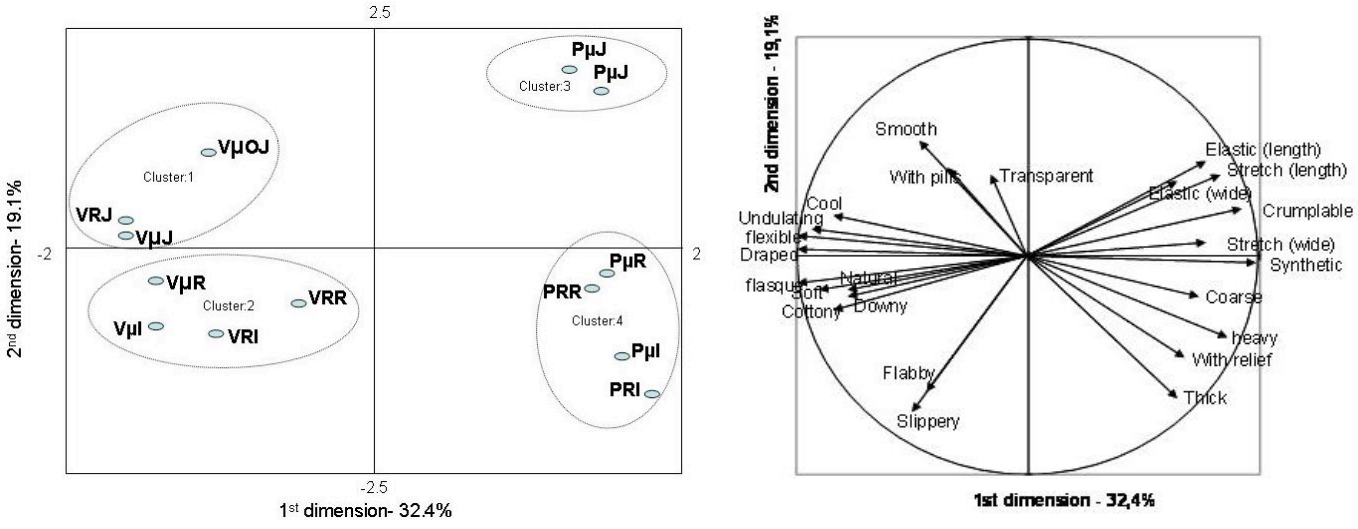

Figure 1: First two dimensions of fabric and attributes maps of fresh fabrics

1st dimension

On the fabrics map (1a) it appears that there is a strong opposition of the viscose fabrics (on the left of the map) vs. the polyester fabrics (on the right of the map), on the first dimension. This means that this is the main difference that the panellists perceived when they run the grouping tasks. It represents 32.4% of the whole variability between products described by panellists. Looking at the terms map, it appears that panellists had a strong tendency to gather the viscose fabrics together because their "cottony", "downy", "synthetic" "Draping", "undulating", "cooling" and "soft" characteristics. Some panellists mentioned that the viscose fabrics gave the feel of being "natural" fabrics, as opposed to the polyester fabrics that to qualified as "synthetic" / "Plastic». The polyester fabrics were put together because of the "synthetic" sensation they provide. They were also described as being creased.

2nd dimension

The second dimension opposes fabrics that have different constructions. The main opposition is between the "Polyester Jersey" fabrics vs. the "Polyester 1x1 rib" and the "Polyester Interlock". The jersey is perceived as elastic and stretch lengthwise, whereas the 1x1Rib and the Interlock are described as having relief and being heavy and thick. Jersey is the most elastic construction among knitted fabrics.

To a lower extend, there is also an opposition between the "Viscose Jersey" (being perceived as smooth and undulating) vs. the "Viscose 1x1 Rib" and "Viscose Interlock" (being described as slippery).

Four clusters have been computed using a hierarchical classification:

- Cluster 1 Viscose with a jersey construction, i.e. fabrics VµJ, VRJ and VµOJ. They were often gathered as they were all perceived as flexible, well-draped, and undulating and smooth.
- Cluster 2 : Viscose with a 1x1 rib or an interlock construction, i.e. VµR, VµI, VRR and VµJRI. They are perceived as downy, cottony, soft, flexible, well-draped and providing a feeling of "natural" fabric.
- Cluster 3 : Polyester with Jersey construction, i.e. PµJ and PRJ (perceived as elastic and stretch in length). Those two fabrics were perceived as creased, elastic and stretch lengthwise.
- Cluster 4: Polyester with a 1x1 rib or an interlock construction, i.e. PµR, PµI, PRR and PRI, characterised by their heaviness, their thickness and their relief.

The material type and the construction are the two key-parameters for sensory perception on our range of products. The fineness of the fibre (regular or micro) is not an important parameter compared to the matter perception.

3.2 Influence of ageing process on sensory hand :-

The panel members were provided with randomly selected knitted fabrics including the fabrics that have gone through 40 washing cycles with and without softener. This time the terms generated were almost the same as before, but some attributes were removed and new attributes were added:

- 'Thickness' and 'Elastic' were removed as according to panelists, it was not possible to differentiate these attributes from 'Light' and 'Stretchable' respectively.
- Panelists introduced three new attributes to study mechanical aspects: Wrinkle, Flairy and Mellow which can be considered as synonyms of crease, undulating and flabby respectively.
- A new attribute was introduced: Greasy which is important in order to check the effect of surface properties with the number of ageing cycles.

The panellists were provided with 52 Knitted samples containing the 13 fabrics shown in Table: 1 which have gone through the following process:-

- Fabrics have gone through 1 washing cycle without fabric softener.
- Fabrics have gone through 1 washing cycle with fabric softener.
- Fabrics have gone through 40 washing cycles without fabric softener.
- Fabrics have gone through 40 washing cycles with fabric softener.

These 4 conditions represent the different type of aging processes use by consumers.

Panellists were asked to rank these 52 fabrics by pair comparison method. They were asked to wash their hand after each attribute in order to remove natural waxes present on their hands which can influence tactile feeling. As the number of samples was very large, panellists were asked to evaluate a maximum of 3 attributes per session to ensure better reliability of scores.

The main objective of the work is to check the influence of ageing on sensory properties of fabric but in fabric mapping of all fabrics together the influence of fibre type is so high that we could only get two clear clusters of viscose and polyester samples. In order to check the results for the influence of other factors, the matrix has to be divided in sub matrices.

Table 2: Sub matrices of sensory evaluation results

S.N.	Fabric samples	Matrix size	Objective
1	All Viscose samples	28X14	To Check the influence of ageing of 40 cycles on viscose knitted textiles
2	All Polyester samples	24X14	To Check the influence of ageing of 40 cycles on Polyester knitted textiles

3.2.1 Ageing of Viscose Samples (S.N. 1, Table: 2):

On the fabrics map (Figure:2), it appears that there is a strong opposition of the viscose fabrics gone through 1 washing cycle (on the left of the map) vs. the fabrics gone through 40 cycles (on the right of the map), on the first dimension. This means that this is the main difference that the panellists perceived when they run the grouping tasks. It represents 40% of the whole variability between products described by panellists. Looking at the terms map, the projection of attributes

Slippery, Drapable Flexible, Fluffy and pilling is maximum on the first principle component, which means that these attributes have maximum variability and are the most relevant attributes with respect to this component.

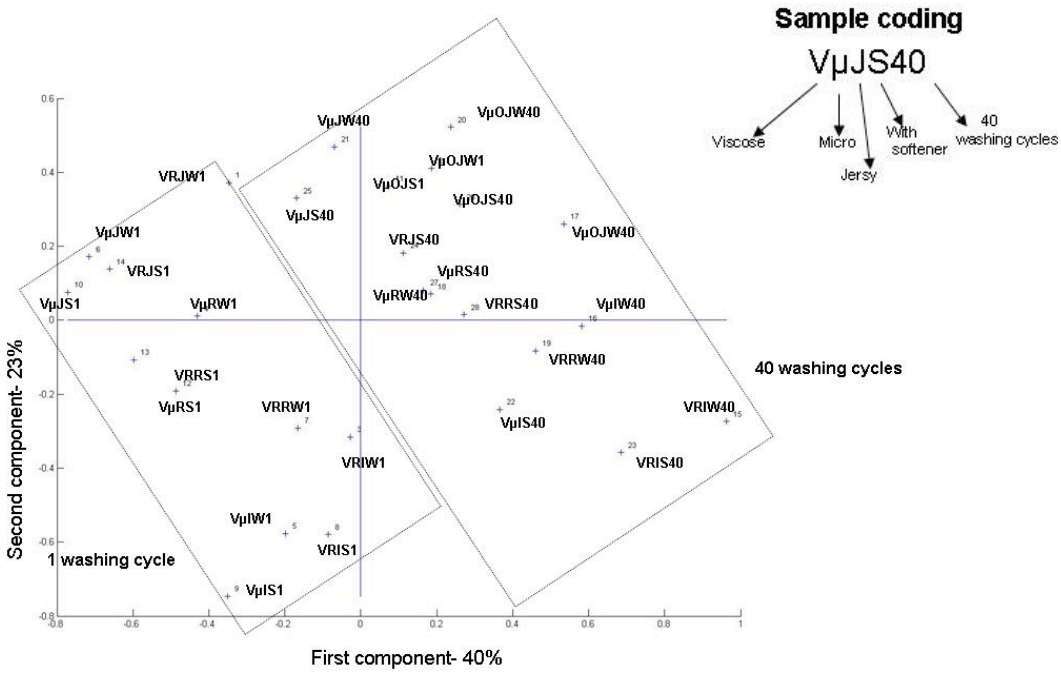

Figure 2: Fabric mapping for all Viscose fabric samples

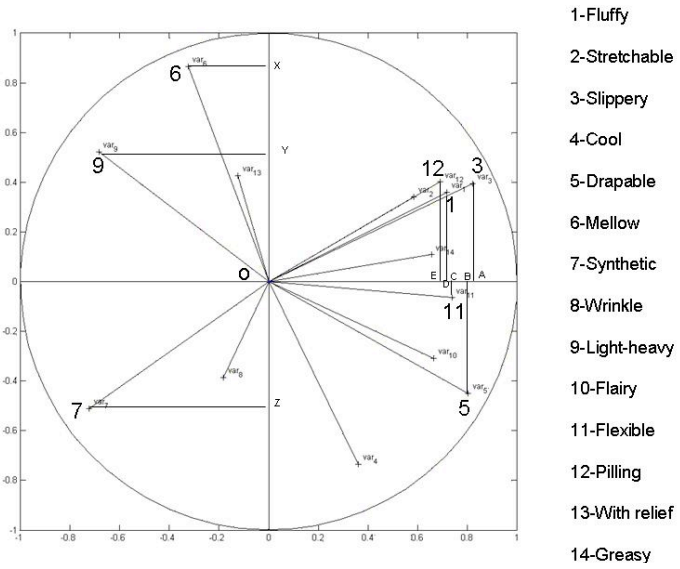

Figure 3: Attribute mapping for all Viscose fabric samples

It appears that panellists had a strong tendency to gather the viscose fabrics which have gone through 40 wash cycles, together because of their Drape, Slippery, Flexible, fluffy and pilling characteristics or we can conclude these are the sensory attributes which are influenced by the repeated washing.

On the fabric map Figure:2, there is an opposition of single jersey and double jersey (Rib and interlock) fabrics on the second component of the map. The attributes Mellow, Light-heavy and synthetic have maximum projection on second principal component that means panellists differentiate single jersey and double jersey fabric on the basis of these attributes.

3.2.2 Ageing of PET Samples (S.N. 2, Table:2): :

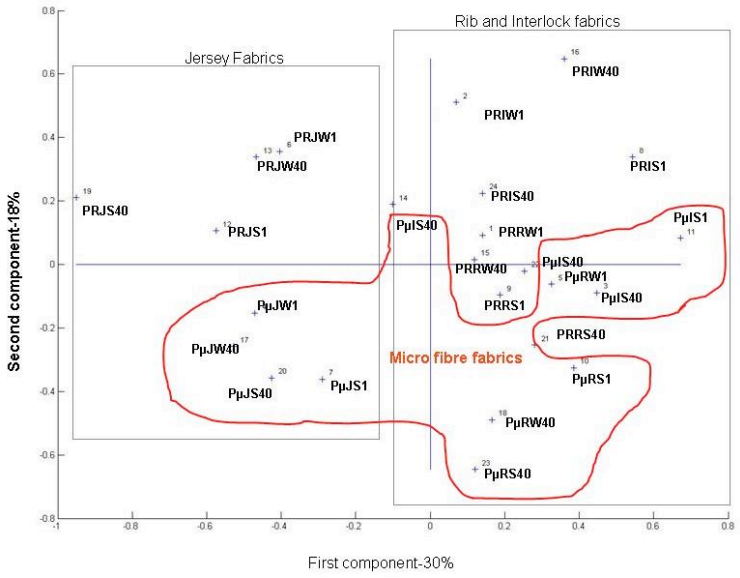

Figure 4: Fabric mapping for all PET fabric samples

Figure: 4 is the fabric map for all Polyester samples, it appears that there is a strong opposition of the single jersey and double jersey (Rib and knitted) on the first dimension. The panellists found that single jersey fabrics can be represented by their light feeling, mellow and with relief characteristics while Rib and double jersey fabrics are greasy, and gives more synthetic feeling on touch. The first component represents 30% of the whole variability between products described by panellists. The second component which represents 18% of data variability, distribute the fabrics on map on the basis of fibre type i.e. micro or regular. It seems that effect of ageing on polyester is not as much as on Viscose because of their highly crystalline region, hydrophobic and mechanically tough characteristic.

Conclusion: The type of fibre and construction of knitted fabrics play important role in sensory evaluation of knitted fabrics, it seems difficult to perceive the difference in sensory feeling of micro fibre and regular fibre. Hence, it's important for the knitting manufacturer to pay great attention to fibre type and knitting structure in order to meet consumer preference.

The tactile properties of textiles don't remain the same from their cradle to grave state; the main cause of change is tough laundry conditions. The influence of ageing on sensory feeling is significant only for viscose fabrics, PET fabrics only slightly change with ageing cycles, which was not perceived by panellists. Drape, Slippery, Flexible, Fluffy, Pilling are the main

attributes influenced by ageing of Viscose. It's important to choose optimum blend of Viscose and Polyester to minimise the influence of ageing on sensory properties. The construction of textile has its impact on sensory feeling even after the certain ageing cycles of fabric.

Acknowledgements: We thank Dr. Kenneth Lee and Dr. Vince Mole and their teams from Unilever Research and Development Laboratory, Port Sunlight for providing their valuable suggestions and guidelines;

REFERENCES:

1. Linfield, W.M., et al., Journal of the American Oil Chemists Society, 19558, Vol. 35(11), 590.
2. Chiweshe, A., & Crews, P. C. "Influence of household fabric softeners and laundry enzymes on pilling and breaking strength", Textile Chemist and Colorist & American Dyestuff Reporter, 32(9), 2000,41-47.
3. Baumert J. Karen, Penney JC, "Influence of Household fabric softener on properties of selected woven fabrics" Textile chemist and colorist" , 28(1), 1996, 36-43.
4. Simpson, H. N., & Silvernale, C. C. (1976). How laundering with fabric softeners affects flame retardant cotton fabrics. American Dyestuff Reporter, 65(1), 36-42, 58.
5. Mackay Colina, Anand C Subhash, Bishop P David, "Effects of Laundering on the sensory and Mechanical properties of 1x1 Rib Knitwear fabrics, Part-1", Textile Research Journal, 66(3), 1996, 151-157.
6. Mackay Colina, Anand C Subhash, Bishop P David, "Effects of Laundering on the sensory and Mechanical properties of 1x1 Rib Knitwear fabrics, Part-2", Textile Research Journal, 69(4), 1999, 252-260.
7. Daukantiene Virginija, Bernotiene, Gautauskas Matas, "Textile Hand : the influence of washing and chemical liquid softener", Fibres and textiles in eastern Europe, 3(51), 2005, 63-66.
8. Orglakcioglu Nida, Marmarali Arzu, "Thermal comfort properties of some knitted structures", Fibres and textiles in Eastern Europe, 15(5), 2007, 94-96.
9. Baker Wann Marjoire, Regan M. Barbara, "The effects of dry cleaning and of laundering with and without fabric softeners on thermal properties of blankets", Textile Research Journal, 49, 1979, 302-308.
10. Sebestian S.A.R.D, Bailey A.I., Briscoe B.J., Tabor D. "Effects of softening agent on yarn pull out force of a plain weave fabric", Textile Research Journal", 56, 1986, 604-611.
11. Solfflet Ivanne, Calonnier Maurice, Dacremont Catherine, "A comparison between industrial experts' and novices' hepatic perceptual organisation: a tool to identify descriptors of the handle of the fabrics", Food quality and preference, 15, 2004, 689-699.
12. Philippe Flora, Schacher Laurence, Adolphe Dominique, "Tactile feeling: sensory analysis applied to textile goods", Textile research journal 74(12), 2004, 1066-1072.
13. Harada Takashi, Saito Minoru, Mastsuo Taatsuki, "Study on the hand- The method of describibg hand", Journal of textile machinery society of Japan, 17(4), 1971, 111-123.
14. Sular Vildan, Okur Ayse, "Sensory evaluation methods for tactile properties of fabrics", Journal of sensory studies 22, 2007, 1-16.
15. Simpson B.G., "The effect of silicone softeners on resin treated cottons", Textile Research Jounal, 28(2), 1958, 170-179.
16. Ward H.L., "Textile softeners for home laundering" Journal of home economics, 49(2), 1957, 122-123.

17. Daukanitiene Virginija, Bernotiene Birute, Gutauskas, "Textile Hand: the Influence of Multiplex Washing and Chemical Liquid Softener, FIBRES & TEXTILES in Eastern Europe, 2005, July/September, Vol. 13(3), 63-66.
18. Alimaa D, Matsuo T., Nakajima M., Takahashi M., "Sensory measurements of the main mechanical parameters of knitted fabrics", Textile Research Journal, 70(11), 2000, 985-990.
19. Prasad A.K., "Novel Effects in Garment Processing and Value Added Finishes", Journal of Textile Association, 2007 June, 39-43.
20. Mishra Shilpi, Tayagi V.K., "Ester Quats: The Novel Class of Cationic Fabric Softeners", Journal of Oleo Science, 2007, Vol. 56(6), 269-276.
21. Zeng Xianyi, Ding Yongsheng, Koehl Ludovic, "A 2-Tuple Fuzzy linguistic model for sensory fabric hand evaluation", book chapter- Intelligent sensory evaluation-methodologies and applications, 217-234.