HANDLE OF COTTON KNITTED FABRICS – INFLUENCE OF PRETREATMENTS

Ana Marija Grancarić, Mário Lima*, Rosa Vasconcelos*, Anita Tarbuk
University of Zagreb, Faculty of Textile Technology
*University of Minho, Engineering School

Abstract

Consumers demand for comfort has been permanently rising. In the last twenty years or so a good progress was achieved in this area resulting in more pleasant fabrics handle. It is well known that this complex fabric property depends on fabric construction, fineness of fibers and finishing treatments, although some chemical and most mechanical finishing processes improve it.
This paper discusses fabric handle characteristics after some stages of cotton pretreatment. For such purpose frictional properties of cotton knitted fabrics were evaluated using a new method of measuring fabric coefficient of friction. Tested cotton fabrics were alkali and enzymatic scoured, prebleached and bleached in laboratory and in industrial conditions. Degree of polymerization, sewability and fabric friction coefficient (μ_{kin}) were measured and evaluated.

Cotton Knitted Fabric, Fabric Handle, Enzyme, Cotton Pretreatment

1. INTRODUCTION

One of the most important demands on textile goods is comfort. Consumers demand for comfort has been permanently rising. In the last twenty years or so a good progress was achieved in this area resulting in more pleasant fabrics handle. It is well known that this complex fabric property depends on fabric construction, fineness of fibers and finishing treatments, although some chemical and most mechanical finishing processes improve it.
This paper discusses fabric handle characteristics after some stages of cotton pretreatment. For this purpose cotton fabrics were alkali and enzymatic scoured, prebleached and bleached in laboratory and in industrial conditions (Grancarić et al., 2005). Alkali scouring results with high effects in textile cleaning of genetic and added impurities as waxes, protein substances, pectin and others, but also leads to some destruction of cotton cellulose. Harsh alkali conditions and high temperature during scouring and bleaching decrease cotton strength and degree of polymerization, as well as reduce mobility of the stitches so that the loop-forming thread is not pushed but pierced, the resulting inflexibility influencing fabric sewability (Grancarić et al., 2001). Sewability is the ability of a fabric to be sewn without holes and drapes. Sewing damage is a usual problem that affects the textile and clothing industries (Stylios et al., 1991). Research on sewability of knits, (Poppenwimmer et al.,1980), (Ujević, Knez and Grancarić, 1993, 2000, 2002) led to better understanding of the complex interactions involved in joining two or more plies of fabrics with a thread. This problem is attributed to fabric properties, pretreatment, finishing, sewing conditions and mishandling.
Harsh conditions during cotton pretreatment also change fabric handle. For such purpose frictional properties of cotton knitted fabrics were evaluated using FRICTORQ surface tester, a new method of measuring fabric coefficient of friction (Lima et al., 2004).
For the purpose of this investigation degree of cellulose polymerization (DP), sewability, in terms of needle penetration force (F) and fabric friction coefficient (μ_{kin}) were measured and evaluated.

2. MATERIAL AND METHODS

Greige 100 % carded cotton circular weft knitted fabric (163 g/m^2), 56 cm width in tubular form with 15 wale/cm and 20 courses/cm was used.
This greige cotton knitted fabric was desized, scoured with alkali and pectinase, prebleached and bleached in Jet apparatus MCS-Urganano-Bergamo, Italy. Alkali scouring was carried out with NaOH (48 %) 5.0 ml/l and nonionic surfactant Kemonecer NI (Kemo) 0.5 g/l at 90 °C for 60 min, followed by rinsing in hot, warm and cold water. Enzymatic scouring was performed in the bath containing BioPrep 3000L 0.1 % (owf), nonionic surfactant Kemonecer NI (Kemo) 0.2 g/l and buffer Na_2HPO_4 at pH 8.2 and 65 °C for 60 min. A commercial Pectate Lyase product BioPrep 3000L (2600 APSU/g – measured by SOP No.: EB-SM 0419, 02/01 method) from Novozymes A/S (Bagsvaerd) was used for bioscouring. Trilon TB, Sodium salt of EDTA (BASF) 0.4 g/l was added for greater removing of pectate at the end of the process, (Zulić and Grancarić 2002). Rinsing at temperature of 80 °C for 15 minutes and washing in hot, warm and cold water was performed. Samples were dried at 65 °C in industrial conditions.
Alkali and pectinase scoured cotton knit fabrics were prebleached and bleached in peroxide baths at 90 °C for 60 min. Prebleaching in mild conditions was performed with H_2O_2 (35 %) 3.0 ml/l stabilized with Tinoclarit CBB (Ciba) 1.0 ml/l, NaOH (48 %) 2.0 ml/l and wetting agent Lavotan TBU (Bezema) 1.0 g/l. Bleaching in harsh conditions with H_2O_2 (35 %) 10.0 ml/l stabilized with Tinoclarit CBB (Ciba) 1.0 ml/l, NaOH 2.0 g/l and wetting agent Lavotan TBU (Bezema) 1.0 g/l was carried out.
Degree of polymerization, DP, was measured according to DIN 54 270 based on limit viscosity of celluloses following Cuen-procedure.
Needle stitch force was measured in CHT - Tübingen using ITV sewability computer system, on Pfaff 483 sewing machine, using type of needle, Nm 80 SES with working speed of 1000 stitch/min on two fabric layers. Needle stitch force is expressed as middle value of 50 measurements.
Friction coefficient was measured with FRICTORQ, a novel fabric surface tester developed at the University of Minho, Portugal. In this instrument, the fabric sample is clamped and forced to rotate around a vertical axis at a constant angular velocity while a vertical load is concentrically applied by a static upper body by means of three small contact sensors, placed in a circle at 120°. The rotary action means that only one reading is needed. Friction coefficient is then proportional to the level of the dragging torque measured on a high precision reaction torque transducer. Providing a relative displacement of approximately 90°, it is assured that a new portion of fabric is always moved under the sensors. Contact pressure is constant during the test. The torque signal is digitalized through an electronic interface and fed into a PC where dynamic or kinetic friction coefficient μ_{kin} is worked out and displayed.

3. RESULTS AND DISCUSSION

Degree of polymerization indicates changes in fiber structure and it is an indirect measure of fiber damage in textile pretreatment. Pectinase scoured knitted fabrics have higher degree of polymerization than alkali scoured ones (Table 1).

Table 1 Treatment and Degree of Polymerisation of Cotton Knitted Fabrics

Sample	Treatment	DP
G	Greige	2968.5
S	Scouring	2312.1
SP	Scouring and prebleaching	1941.2
SB	Scouring and bleaching	1808.1
E	Enzymatic scouring	2647.3
EP	Enzymatic scouring and prebleaching	2419.6
EB	Enzymatic scouring and bleaching	2201.7

Prebleaching and bleaching decrease DP of cotton knit fabrics, but less in the case of enzymatic scoured fabrics. Pectinase scoured fabrics are less damaged (higher DP) than alkali scoured, what is additionally confirmed by sewability results.

Table 2 Needle Stitch Force and Fabric Friction of Cotton Knitted Fabrics

Sample	Needle Stitch Force		Kinetic Friction Coefficient	
	F [cN]	Variation Coefficient CV [%] (n = 50)	μ_{Kin}	Std. Deviation s (n = 12)
G	391.6	22.1	0.2860	0.00753
S	667.2	32.6	0.2878	0.00677
SP	689.0	33.0	0.2826	0.00323
SB	952.9	36.8	0.2810	0.00745
E	451.4	25.9	0.2946	0.00469
EP	413.4	25.3	0.2907	0.00588
EB	534.6	28.6	0.2843	0.00212

Needle stitch penetration force on greige cotton knitted fabric is relatively low (391,6 cN), mostly due to cotton impurities (Tab. 2, Fig. 1), which protect the fibres. In fact, scouring, prebleaching and bleaching increase needle stitch penetration force. It is lower for enzymatic scoured and bleached (EB) cotton knitted fabrics than for alkali scoured and bleached one (SB). Smooth surface and soft handle accomplished by enzymatic scouring are the necessary effects for better cotton knitted fabric sewability. It is well known that similar effects of alkali scoured cotton knitted fabric are obtained when softeners were applied. Softening of cotton fabrics minimizes the penetration and withdrawal forces of the needle during the sewing.

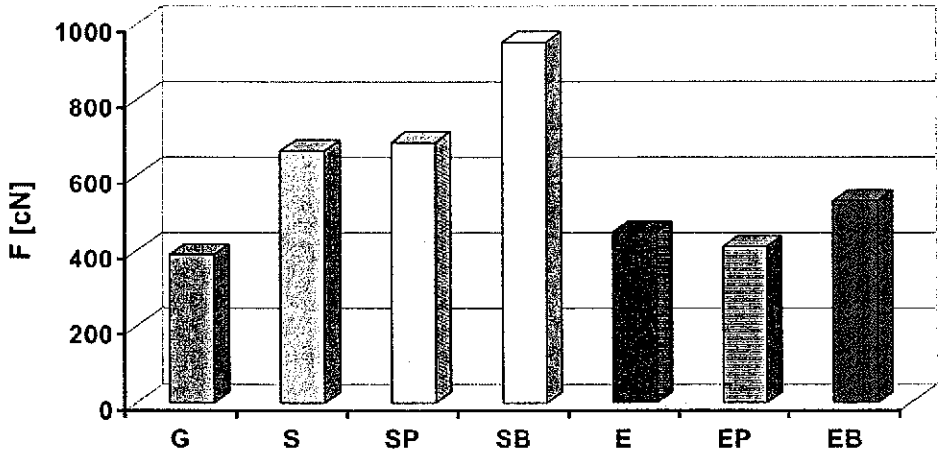

Figure 1 Needle Stitch Force for Cotton Knit Fabric

According to the obtained results (Tab. 2, Fig. 2) it is shown that enzymatic treated cotton gives always the higher coefficient of fabric friction. The μ_{kin} mean values for differently treated cotton show expected highest value for enzymatic scoured (E) and very low value for alkali scoured and bleached cotton (SB) treated in a harsh bleaching condition. The later cottons fabrics have very high penetration force (F = 952,9 cN), not only because of cotton damages but also for the reason of low friction. The μ_{kin} mean values for alkali scoured cotton (S) are lower compared with enzymatic scoured (E).
It means that the lower penetration force obtained for enzymatic scoured cottons is not only because such cotton is not damaged but also due to the removal of some cotton impurities that show poor handle. The μ_{kin} mean value for alkali scoured and prebleached cotton is lower than enzymatic scoured and prebleached ones as the result of the harsh conditions in alkali scouring. Needle stitch force for alkali scoured and bleached cotton is high (F = 689,0 cN) as a consequence of the low DP. Now, we can add the low μ_{kin} mean value as another reason for the high penetration force. Alkali scoured and bleached cotton shows only a little lower μ_{kin} mean value compared with enzymatic scoured and bleached ones.

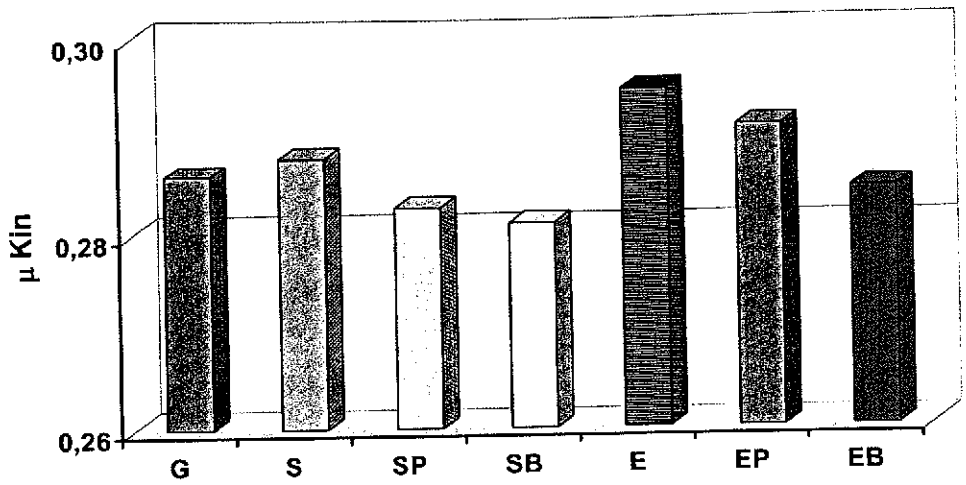

Figure 2 μ_{kin} with FRICTORQ (3,5 kPa) for Cotton Knit Fabric

Although not statistically significant, this phenomenon has appeared because for the bleaching effects it is not so important what has been done before this strong chemical treatment.

4. CONCLUSION

Needle stitch penetration force on greige cotton knitted fabric is relatively low, mostly due to cotton impurities which protect the fibres. Scouring, prebleaching and bleaching increase needle stitch penetration force. It is lower for enzymatic cotton knitted fabrics. Smooth surface and soft handle accomplished by enzymatic scouring are the necessary effects for better cotton knitted fabric sewability.

The lower penetration force obtained for enzymatic scoured cottons is not only because such cotton is not damaged but also due to the removal of some cotton impurities that show poor handle. The μ_{kin} mean value for alkali scoured and prebleached cotton is lower than enzymatic scoured and prebleached ones as the result of the harsh conditions in alkali scouring. Needle stitch force for alkali scoured and bleached cotton is high as the consequence of the low DP. Pectinase scoured knitted fabrics have higher degree of polymerization than alkali scoured ones. Prebleaching and bleaching decrease DP of cotton knit fabrics, but less in the case of enzymatic scoured fabrics. Pectinase scoured fabrics are less damaged (higher DP) than alkali scoured ones.

Enzymatic treated cotton gives always the higher coefficient of fabric friction. The μ_{kin} mean values for differently treated cotton show expected highest value for enzymatic scoured and very low value for alkali scoured and bleached cotton treated in a harsh bleaching condition. The later cottons fabrics have very high penetration force, not only because of cotton damages, but also for the reason of low friction. The μ_{kin} mean values for alkali scoured cotton are lower compared with enzymatic scoured ones. Now, we can add the low μ_{kin} mean value as another reason for the high penetration force. Alkali scoured and bleached cotton shows only a little lower μ_{kin} mean value compared with enzymatic scoured and bleached ones. Although not statistically significant, this phenomenon has appeared because for the bleaching effects it is not so important what has been done before this strong chemical treatment.

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ADDITIONAL DATA ABOUT AUTHORS

Prof. Ana Marija Grancarić, Ph. D., Vicedean for Science and International Relations, University of Zagreb, Faculty of Textile Technology, Department of Textile Chemical Technology and Material Testing, Pierottijeva 6, HR-10000 Zagreb, Croatia, E-mail: amgranca@ttf.hr, Phone: ++385 1 48 77 360, Fax: ++385 1 48 77 355

Prof. Mário Lima, Ph. D., University of Minho, Department of Mechanical Engineering, 4800-058 Guimarães, Portugal, E-mail: mlima@dem.uminho.pt, Phone: 351 253 510226 , Fax: 351 253 516007

Prof. Rosa Vasconcelos, Ph.D, University of Minho, Department of Textile Engineering, 4800-058 Guimarães, Portugal, E-mail: rosa@det.uminho.pt, Phone: 351253 510292, Fax: 351 253 510293

Anita Tarbuk, B. Sc., University of Zagreb, Faculty of Textile Technology, Department of Textile Chemical Technology and Material Testing, Pierottijeva 6, HR-10000 Zagreb, Croatia, E-mail: anita.tarbuk@ttf.hr, Phone: ++385 1 48 77 365, Fax: ++385 1 48 77 355