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Moisture management properties of Cupro knitted fabrics

G Durur[1], E Oner[2] and G Gunduz[1]

[1]Pamukkale University, Textile Engineering Department, Denizli, Turkey
[2]Usak University, Textile Engineering Department, Usak, Turkey

Email: eren.oner@usak.edu.tr

Abstract. On the purpose of analysing the moisture management behaviour of Cupro blend knitted fabrics made of Ne 40/1 and Ne 56/1 cotton/Cupro blend yarns, which have single jersey, 1x1 rib and interlock knitting types were systematically produced. Multi-dimensional liquid transport properties of the produced fabric were measured on the Moisture Management Tester (MMT). The air permeability and some structural properties of the fabrics were also measured, and the results were evaluated taking into account moisture management properties. According to results, it is observed that moisture management capacity and permeability of Cupro blends produced from finer yarns were higher than those of fabrics from coarse count yarns. Generally, Cupro blend knitted fabrics showed good moisture management properties.
Keywords: Cupro fabric, knitted fabric, moisture management, water transport, permeability.

1. Introduction

The solvation of cellulose in a mixture of copper oxide and ammonia was discovered by Swiss chemist Matthias Eduard Schweizer in 1857, and this principle had been the basis in Germany for the production initially of incandescent bulbs (1891), then of cuprammonium fibres (1897) via the so-called “Cupro” process, which was improved with the draw-spinning process (1891) and resulted in the production of Bemberg Cupro yarn in 1909 [1]. The process is still used today, but the relatively high costs associated with the need to use cotton cellulose and copper salts prevented it from reaching the large scale of manufacture achieved by the viscose rayon process [2]. Due to the bright and smooth fibre structure of cuprammonium rayon, it is mostly used to make fine filaments that are used in lightweight summer dresses and blouses, and sometimes Cupro fabrics used with cotton combination to make textured fabrics with clubbed, uneven surfaces.

Although it is such an old fibres process, today there are a quite few research papers except for certain properties of Cupro fibres as pleasant hand, drapeability and biocompatibility [3-6]. In this case, the investigation of the comfort parameters of the Cupro, which calls “artificial silk” with its extreme fineness and softness, will be important. Cupro fabrics are commonly used in summer clothes, and so that sweat transfer from skin surface by clothing is an important requirement for these fabrics in hot weather. Moisture management properties of the fabrics are one of the most important comfort parameters that determine the person’s comfort perception. Even if researchers have studied the moisture management properties of some fabrics [7-11], there are no published papers which investigate the moisture management properties of Cupro fabrics experimentally. This research examined the moisture management and air permeability properties of the Cupro blend knitted fabrics made of Ne 40/1 and Ne 56/1 cotton/Cupro blend yarns, which have single jersey, 1x1 rib and interlock knitting types.

2. Materials and methods

Six types of knitted fabrics, having two different linear densities of 50/50% cotton/Cupro yarn (Ne 40/1 and Ne 56/1 ring spun) and three different knitting types (Single jersey, 1x1 rib and interlock) were systematically produced. All fabrics were produced on Mayer&Cie circular knitting machine with 28 gauge on 30“ diameter. The physical and structural properties determined according to related standards of knitted fabrics used in this study are presented in Table 1.

Table 1. The physical and structural properties of the cotton/Cupro knitted fabrics

Sample Code	Raw Material	Yarn Count (Ne)	Knitting Type	Weightiness (g/m^2)	Thickness (mm)	Wales /cm	Courses /cm
1.1	Cotton/Cupro	40/1	Single Jersey	131.23	0.62	23.33	15.00
1.2	Cotton/Cupro	40/1	1x1 Rib	170.18	0.74	19.00	12.00
1.3	Cotton/Cupro	40/1	İnterlock	213.79	0.86	22.00	12.66
2.1	Cotton/Cupro	56/1	Single Jersey	115.97	0.60	21.66	18.66
2.2	Cotton/Cupro	56/1	1x1 Rib	111.20	0.54	18.33	12.33
2.3	Cotton/Cupro	56/1	İnterlock	160.10	0.95	19.66	14.33

The fabrics used in the study were preconditioned in a conditioning room at standard atmospheric conditions (20 ± 2°C, 65 ± 2% RH) for 24 hours. The air permeability tests of fabrics were performed with Textest FX 3300 Air Permeability Tester, and the measurements were repeated 10 times for each fabric at 20 cm^2 applied test area under 100 Pa test pressure, which was determined for fabrics according to ASTM D737-04 test standards, and at l/m^2/s as the measurement unit. By using Moisture Management Tester (MMT), the measurements of multi-directional liquid transmission properties were performed in accordance with AATCC Test Method 195-2009, and the measurements were repeated five times for each of the knitted fabrics.

The obtained results were evaluated with a multivariate analysis, followed by a post hoc test (Student Newman, Kuel - SNK) by using SPSS for Windows 22.0 statistical package program. For all statistical analyses, $p<0.05$ (95% confidence interval) was considered to be significant.

3. Results and discussion

Air permeability and moisture management results of the cotton/Cupro knitted fabrics are presented below. The results of variance analyses of the measurements and the differences between each group have been explained using the SNK post hoc test. The results of SNK test are given in Table 2.

Table 2. SNK post hoc results of the cotton/Cupro knitted fabrics

Main effects		Air Permeability	AOTI	OMMC
Yarn count	Ne 40/1	1380 a	238.34 a	0.5348 a
	Ne 56/1	2979 b	472.50 b	0.6709 b
Knitting Type	Single Jersey	2359 b	319.73 a	0.6170 a
	1x1 Rib	2104 a	500.59 b	0.6702 a
	Interlock	2075 a	245.94 a	0.5215 a

The average values are arranged such that the letter ‘a’ shows the lowest average value and the letter ‘b’ shows the highest average value. Any two average values not sharing a letter in common mean that they are significantly different from each other at 95 % level.

3.1. Air permeability

The results of air permeability of the fabrics are shown in **Figure 1**. Air permeability values for Cupro blend knitted fabrics vary between 1215 and 3241 l/m^2/s. Air permeability values for knitted fabrics made of Ne 56/1 yarns have tended to be higher than fabrics made of Ne 40/1 yarns. This condition is associated with the pore structure of fabrics. Finer yarns cause the increment of porosity in the fabric structure, and thus fabric permeability increases. Yarn count has statistically significant effects on air permeability ($p<0.05$). Among knitting types, single jersey fabrics have the highest values in both yarn count. In fact, single jersey fabrics caused the statistical differences among the knitting types as seen in the SNK results ($p<0.05$).

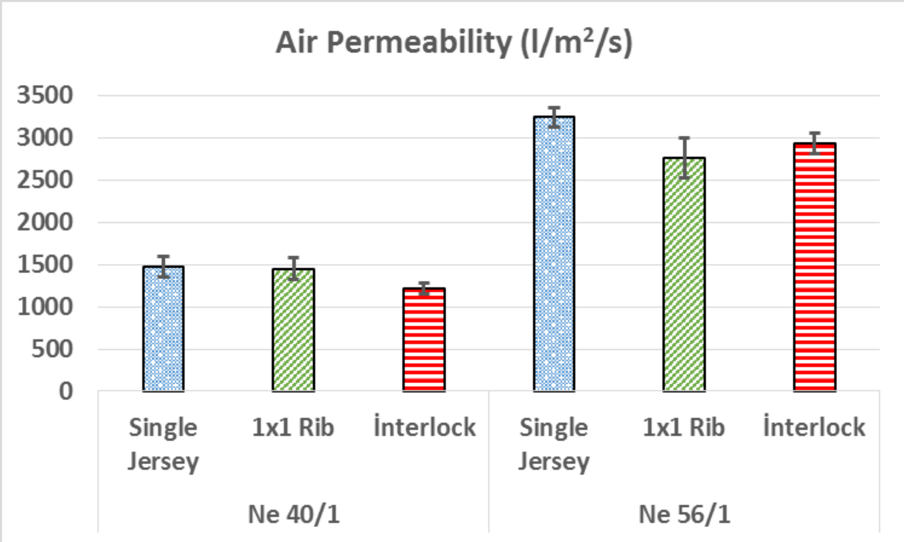

Figure 1. Air permeability results of the cotton/Cupro knitted fabrics used in the study.

3.2. Moisture management

According to the AATCC Test Method 195-2009, wetting time (top-bottom), absorption rate (top-bottom), maximum wetted radius (top-bottom), spreading speed (top-bottom), accumulative one-way transport capacity index (AOTI) and overall moisture management capability (OMMC) of fabrics were measured by MMT which were used to determine liquid moisture transport properties in multi dimensions. Among these indexes, AOTI, which shows the cumulative moisture difference between two surfaces of fabric, and OMMC, which shows all performance of liquid moisture obtained by calculating other indexes on fabric, give a general idea related to liquid moisture comfort [12]. The AOTI and OMMC results of fabrics are shown in Figure 2 and Figure 3, respectively.

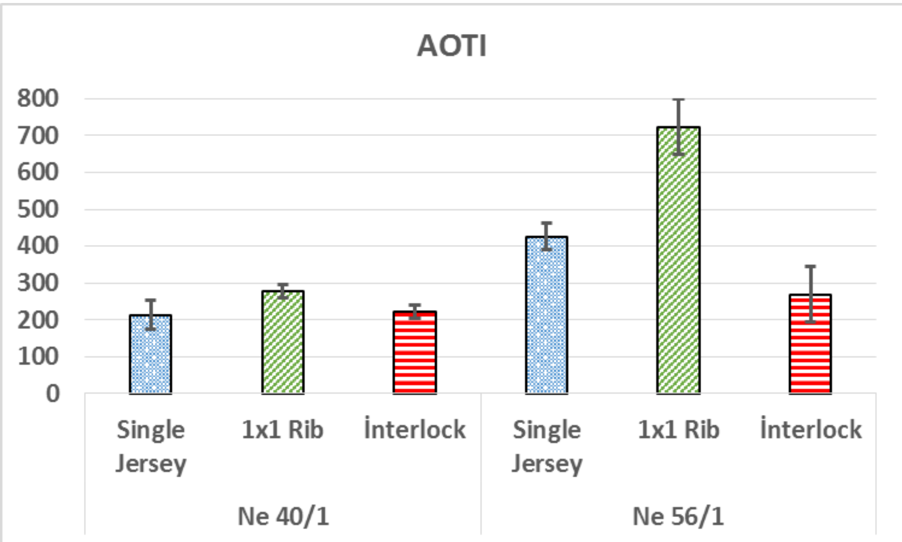

Figure 2. AOTI values of the cotton/Cupro knitted fabrics used in the study.

According to the AOTI results, it is observed that the values of the fabrics produced from 56/1 yarns are higher than those of the fabrics made of coarser yarns. Besides, yarn count parameter has statistically significant effect on the AOTI ($p<0.05$). For all types of knitted fabrics, the highest values are observed with the 1x1 rib knitted fabrics produced from Ne 56/1 yarns. At the same time, the measurement results of AOTI of 1x1 rib fabrics are the highest among the fabrics made of Ne 40/1 yarns. According to SNK post hoc test, there are no significant differences between single jersey and interlock fabrics for the AOTI values, and these fabrics take place in the same subset group. The high AOTI values for 1x1 rib fabrics may be related to the low weightiness and thickness of these fabrics. Also, because of the even distribution of knit and purl stitches on the front and back side, 1x1 rib knitted fabrics show same characteristic on both sides, and this condition may provide an advantage to those fabrics in terms of one-way moisture transport between two surfaces.

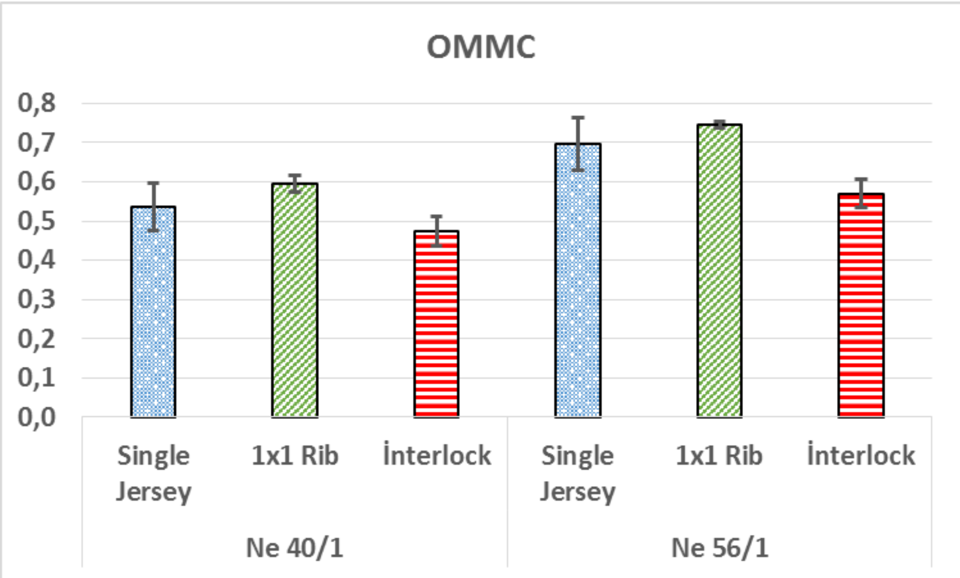

Figure 3. OMMC values of the cotton/Cupro knitted fabrics used in the study.

OMMC values were measured in the range 0.54-0.70 for single jersey fabrics, 0.59-0.75 for 1x1 rib fabrics and 0.47-0.57 for interlock fabrics. This condition shows that liquid moisture management capacities of the cotton/Cupro fabrics take place between “good” and “very good” grades in the grading table of Yao et al., who invented MMT device, in terms of moisture management [13]. Fabrics made of finer yarns have higher values, and also single jersey and 1x1 rib fabrics produced from finer yarns have superior liquid moisture management capacity. Although yarn count has statistically significant effect on OMMC ($p<0.05$), there are no significant differences between knitting types for OMMC values according to SNK ($p>0.05$). Consequently, yarn fineness is the determining parameter in terms of multidirectional liquid moisture transport performance, and knitting type does not reveal a remarkable difference for its performance.

4. Conclusion

Regenerated cellulose fibers are gaining importance in the textile industry with increasing demand for garment comfort and natural hand. There are many studies related to the comfort properties of regenerated fabrics. However, comfort characteristics of fabrics containing Cupro, which was found too early and has some important hand properties in the market, are yet to be investigated thoroughly. In light of this fact, this study focused at analyzing and determining the moisture management and permeability properties of Cupro blend knitted fabrics which have different yarn counts and knitting types.

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In the light of the results, it is observed that yarn count, thickness and mass per unit area values of the fabrics determine the moisture transport capacity of the fabrics. On the other hand, the use of finer yarns in the fabric structure provides high air permeability and water transport properties. On the basis of the results obtained, 1x1 rib knitting types have the highest moisture management capacity values in both yarn count. This finding indicates that the 1x1 rib Cupro blend fabrics have quick water transfer ability compared to others, and these fabrics may be used for activities where sweating occurred. It is also pointed out that, single jersey fabrics show outstanding air permeability results, and this Cupro blend fabrics may have some advantages in terms of comfort for mild activities where excessive sweating does not occur. Accordingly, it has been determined that Cupro blend knitted fabrics show good moisture management properties, generally.

The findings of this study may be helpful for further approaches on the using of Cupro textiles and understanding their moisture management properties, and also the experimental results may provide useful information for researchers and producers. Further researches should focus on the investigation of the performance of Cupro fiber of different blend ratios with other fibers, performance of knitted and woven Cupro fabrics as well as their behavior in dyeing and finishing processes.

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