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EFFECT OF LAUNDERING ON UV PROTECTION PERFORMANCE OF UMORFIL BASED FABRICS

Sena CİMİLLİ DURU, Cevza CANDAN, Banu NERGİS

Faculty of Textile Technologies and Design, Istanbul Technical University (ITU), Istanbul, Turkey
cimilli@itu.edu.tr

Abstract*. Intense UV exposures might result in sunburn, photo-aging, melanoma, even DNA damages, and cell death. Most important result between them is melanoma. Therefore, it is critical for individuals, in particular for children to get protected from the harmful effects of UV rays as much as possible and in that respect, the safest protection mean is provided by clothing. Accordingly, for improving UV protection as well as moisture related comfort performances, a rib based knitted fabric was developed using innovative Umorfil-viscose and Umorfil-PET (staple) yarn combinations with lyocell and conventional polyester spun yarns. In an attempt to investigate the effect of washing on the aforementioned properties of the developed fabrics, they were washed at 30ºC and 800 rpm using a 45-minute laundering program. Also, two different types of commercially available detergents, with and without optical brightener, were employed for washing. The samples were subjected to five repeated laundering cycles. Subsequently, the UV protection performance (EN 13758-2), water vapor permeability (ASTM E96-00), air permeability (ASTM D737-18) and wicking (DIN 53924) performances of the washed fabrics were measured. It was observed that the performance of the fabrics varied according to washing and detergent type. It has also been determined that the performance of knitted fabrics made of 100% Umorfil fibers tended to be better.*

Keywords: *UV protection, Umorfil fiber, thermal comfort, detergent type, knitted fabric*

INTRODUCTION

UV rays are a major threat to human health due to climate change and ozone layer thinning. Sunburn, premature aging, allergies, and skin cancer are all caused by UV rays [1]. Clothing can provide good UVR protection and play an important role in avoiding many of the harmful effects of these radiations. When UVR impacts a textile material, some of it is unimpededly transmitted, some is dispersed, and some is absorbed by the material and converted into other forms of energy. Normally, a textile material is considered to provide adequate UV protection if it transmits less than 6% of total incoming UVR, but a value of less than 2.5% is considered excellent [2]. UV-protection characteristics of the fabrics are affected by many textile properties. These parameters include fiber type, yarn properties, fabric construction, finishing process, coloration process, cover factor, weight and thickness [1-20]. Moreover, optical brightening agents demonstrates a significant increase of UPF values in the past (Schindler et al, 2004) and are generally incorporated into fabrics in order to enhance the whiteness of textiles by UV excitation and visible blue emission. Most of the OBA has excitation maxima within the range of 340-400 nm and it is shown that OBA can effectively improve the UPF of cotton and cotton blend fabrics, rather than polyester or nylon fabrics [21].

Umorfil, which originates from upcycled collagen peptide amino acids extracted from fish scales and employed to form collagen based polymers via a supramolecular technology, helps to improve skin health and feel extremely comfortable on the skin due to the collagen peptides and amino acids it contains, which boost blood flow and make the skin more elastic. Umorfil has also been shown to offer good UV protection. It is claimed that UV-B protection of Umorfil is 10 times more than cotton [22, 23]. There are some other works focusing mostly on thermal/moisture related properties of textiles from Umorfil fibers and their blends [24-28]. However, as the literature survey suggests there is lack of knowledge on the effect of house type laundering, in particular detergent type wise, on UV protecting performance of Umorfil fiber based knitted fabrics, and accordingly the study was conducted in order to not only address this gap. In doing so, these fabrics' some comfort related properties were also investigated as a holistic fabric engineering approach.

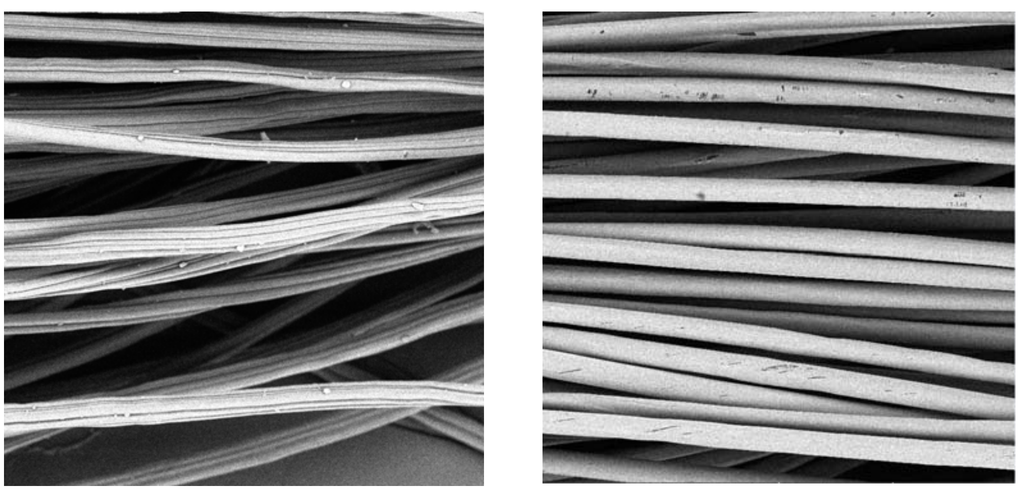
EXPERIMENTAL PART

In the study, 100% Umorfil viscose and 100% Umorfil polyester fibers were used as raw materials. In order to test the performance of these materials, 100% staple polyester and 100% lyocell yarns were also included in the study. The yarn count (TS 244 EN ISO 2060), twist (TS 256), and strength (TS EN ISO 2062) of the yarns used in the study were tested according to relevant standards. The properties of the yarns used in the study are given in Table 1. Figure 1 shows the SEM images of Umorfil viscose and Umorfil PET yarns at 1000X magnification level.

Table 1

Yarn properties

No	Yarn type	Yarn count & (CV%)	Evenness (CV_m%)	Twist (t/m)/(CV%) α_e	Elongation (%) & (CV%)	Strength -cN & (CV%)
1	100% Lyocell	Ne 29.3 (1,12)	11,53	815/(2,50) (α_e 3,82)	14 – 5,6	474 – 8,93
2	100% Umorfil viscose	Ne 29,6 (0,55)	10,24	763/(0,45) (α_e 3,56)	17 – 6,58	304 – 5,09
3	100% PET	Ne 29,6 (0,55)	13,96	880/(2,55) (α_e 4,10)	15 – 4,54	493 – 3,93
4	100% Umorfil PET	Ne 30,3 (0,55)	10,61	852/(3,93) (α_e 3,95)	16 – 5,56	399 – 4,51



A B

Figure 1. A- Umorfil viscone B-Umorfil PET

For the fabrics to be developed within the scope of the study, Shima Seiki E14, a compact flat knitting machine with 2 systems and the APEX design system working together with the machine were used. The rib-based structures were produced in line with the stitch notations developed and presented in Figure 2, and Figure 3 shows the microscopic view of the fabric. In doing so, the hybrid yarn feeding plan was applied such that two ends from Yarn 1 and two ends from Yarn 2 were fed to the needles as given in Table 2. The final yarn count has accordingly become around Ne 7-8.

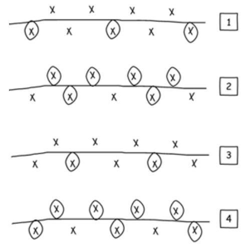


Figure 2. Stitch notation

Figure 3. Fabric microscopic view

Then, the samples were washed five times at 30ºC and 800 spin cycle in a 45-minute washing program. However, in terms of end-user performance of the products to be developed, the content of the detergent used is as important as the washing conditions. Based on this, the washing cycle was repeated with two types of commercial detergents with and without optical brighteners. Finally, weight (TS EN 12127), thickness (TS 7128 EN ISO 5084), UV protection performance (EN 13758-2), water vapor permeability (ASTM E96-00), air permeability (ASTM D737-18), wicking height as well as capacity (DIN 53924) values of the washed and unwashed samples were measured.

Table 2

Fabric properties

Yarn 1	Yarn 2	Thickness (mm)			Stitch density (loop/cm^2)			Weight (g/m^2)			Porosity (%)		
		Greige	Washed		Greige	Washed		Greige	Washed		Greige	Washed	
			NOB*	WOB*		NOB	WOB		NOB	WOB		NOB	WOB
100% Lyocell	100% Umorfil viscone	1,81	1,9	1,9	160	240	240	413,85	465,61	467,62	84,96	83,88	82,88
100% PET	100% Umorfil PET	2,38	2,06	2,1	160	240	240	434,94	515,52	552,31	85,36	80,01	81,6
100% Umorfil PET	100% Umorfil PET	2,26	2,09	2,19	160	240	240	453,74	553,74	551,48	86,81	82,57	82,33
100% Umorfil PET	100% Umorfil viscose	2,06	2,08	2,13	160	240	240	439,89	554,34	566,77	84,58	80,73	81,34
100% Umorfil viscose	100% Umorfil viscose	1,8	1,79	1,75	160	240	240	396,98	470,05	483,54	85,46	82,76	80,57

*No optical brightener.
** With optical brightener.

3. RESULTS AND DISCUSSION

3.1. UVR Performance Results

A may be seen in Figure 4, both the washing process itself and the detergent type are important parameters for the UV protection performance of the samples. In addition, their effect is more significant for the fabrics made from 100% Umorfil-PET and the ones where Umorfil-PET is one of the constituent components of the feeding scheme, when compared to that of the fabrics made of "lyocell-Umorfil Viscose" and "100% Umorfil Viscose". Also, it is clear that the detergent with optical brightener do have a more significant and positive effect on UV performance of the samples, and this very effect has been increased by the inclusion of Umorfil-PET into the structures (Figure 3), which are altogether promising results for the design of UV protective clothing made from Umorfil-PET fibers.

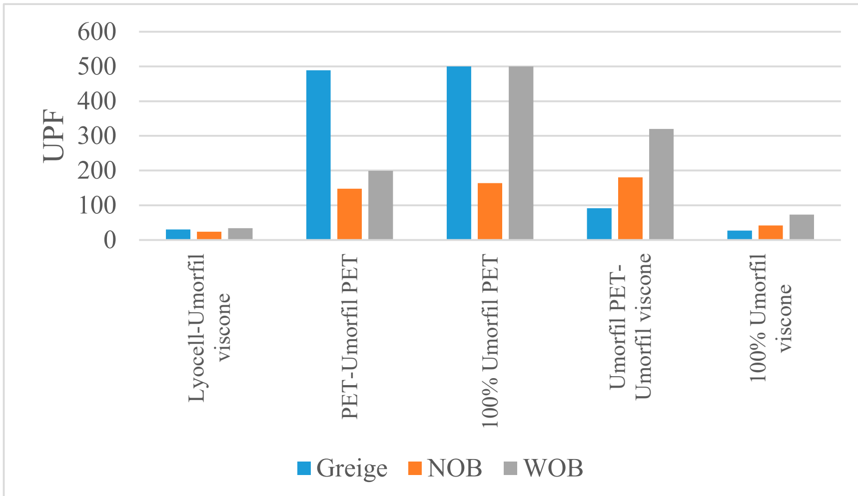


Figure 4. Effect of washing and detergent type on UV protection

3.2. Air Permeability Results

Figure 5 shows the impact of the washing as well as the detergent type of the air permeability of the samples, and as may be seen from the figure the air permeability values of all samples tend to decrease as was expected. Also, for each yarn feeding scheme and the corresponding fabric structure, the air permeability performance appears to be affected by the detergent type such that the washing with the detergent having optical brightener resulted in less compact and more permeable fabric geometries (Table 2). This may be due to the brightening agent depositing on the yarns, that in turn decelarates the relaxation behavior of the structures to some extent, though further study is needed for more elaborative discussion.

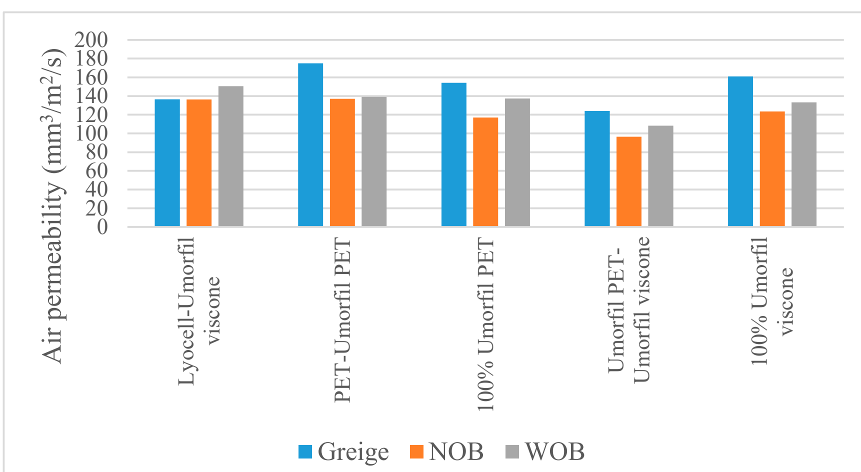


Figure 5. Effect of washing and detergent type on air permeability results

3.3. Water Vapor Permeability Results

Figure 6 reveals that the water vapor permeability increased for the laundered samples, regardless of the yarn feeding scheme as well as of the detergent type. In general, the fabrics made of 100% Umorfil Viscose showed better water vapor permeability performance than the others. Also, it appears that the detergent type is influential on the water vapor permeability values of the fabrics, but the trend observed changes direction depending on the yarn components involved such that "PET-Umorfil PET" and "100% Umorfil Viscose" fabrics performed the best permeability performance when washed with the detergent containing optical brightener whereas the other samples suggest an opposite trend (Figure 5).

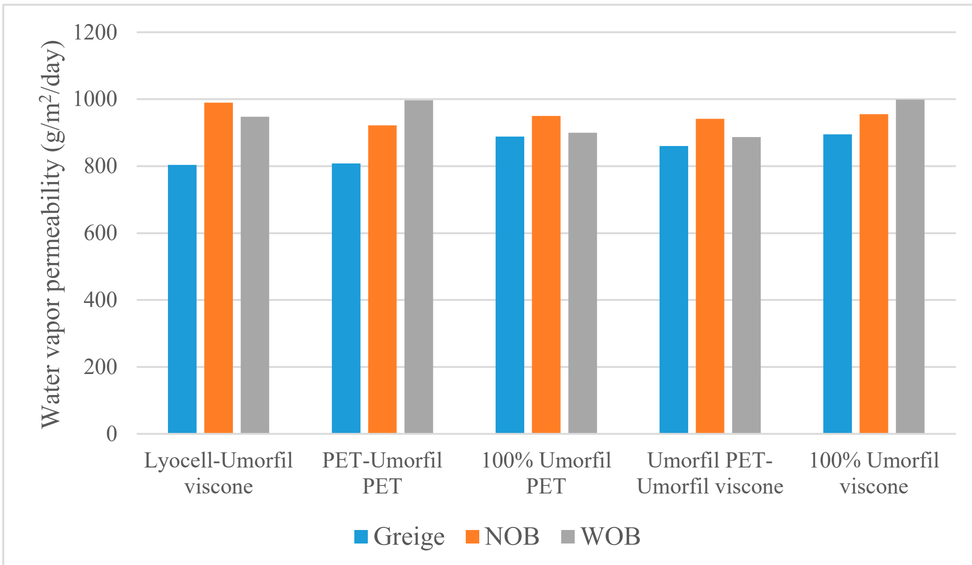
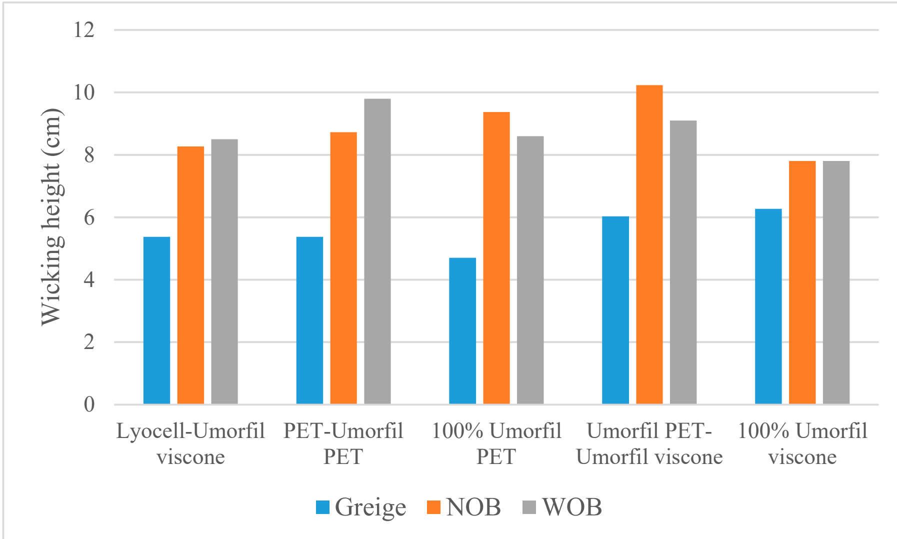


Figure 6. Effect of washing and detergent type on water vapor permeability results

3.3. Wicking Results

Figure 7 demonstrates that irrespective of the yarn components involved in the structures and the detergent type used for the laundering process, the wicking height and capacity of the samples increased after the washing process. This may be due to the increased capillarity within the fabrics as a result of changing structural properties (Table 2). Among these structures, the one containing "Umorfil PET -Umorfil Viscose" yarns showed the best wicking height performance, and it was followed by the sample from 100% PET-Umorfil PET. In addition to that, a comparative study of the laundered 100% Umorfil PET and "Umorfil PET-Umorfil Viscose" structures showed that the samples washed with the detergent containing optical brightening agent, presented worse wicking height performance than those laundered with the other type (i.e. no optical brightener) (Figure 7-A). This may be due to the fact that the deposited agent on the yarns can hinder the rise of the water within the capillars. Furthermore, when it comes to the wicking capacity the structures, it is "100 % Lyocell -Umorfil Viscose" structure that gave the highest water holding capacity, irrespective of the detergent type. It was followed by "Umorfil PET-Umorfil Viscose" structure. As a final note, it appears that having polyester based yarns only (i.e. PET, Umorfil PET) within the structures deteriorates the wicking capacity of the structures (Figure 7-B), and moreover the detergent type may define the degree of degradation in this water retention capacity.



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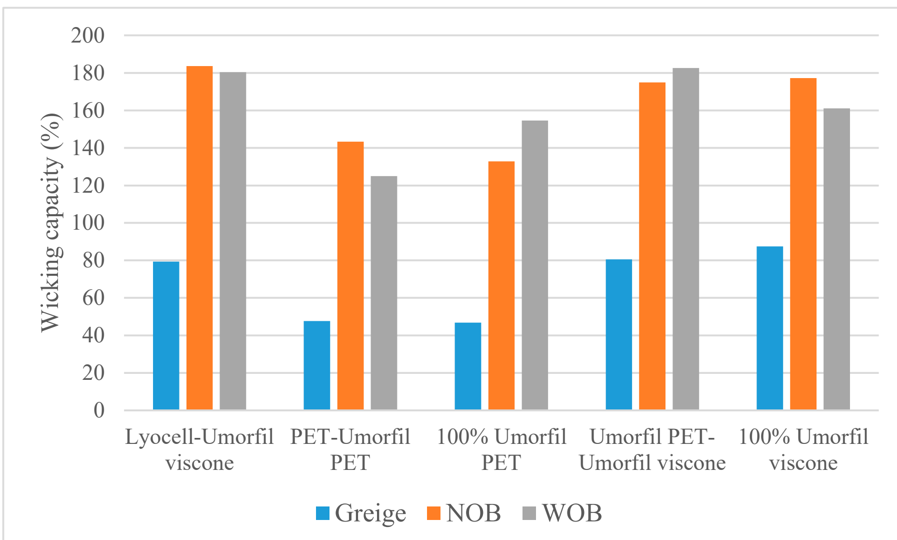

B

Figure 7. Effect of washing and detergent type on A-Wicking height B-Wicking capacity

4. CONCLUSIONS

The study has focused on UV protective performance of Umorfil based knitted fabrics. In doing so, the main concern of the work is the effect of laundering, the detergent type (with/without optical brightener) in particular, on this very performance. Being skin friendly and environmentally friendly fiber, it was shown that the developed rib based knitted fabrics from "100% PET- Umorfil PET" as well as "100% Umorfil PET" yarn components offered satisfactory UV protective performance, but after the washing process this performance tended to deteriorate at varying degrees when the detergent without optical brightener was employed. So far as the laundered structures made from the "Umorfil PET-Umorfil Viscose" and "100% Umorfil Viscose yarns, the laundering process improved the UVR performance, and this improvement was more distinctive when the detergent with optical brightener was used. As a final note, the results demonstrated that the laundering, together with the detergent type employed for it, did not have a significant effect on UVR performance of the fabrics made of the Lyocell-Umorfil Viscose yarn components.

Regarding the comfort related properties of the structures, it was observed that irrespective of the yarn feeding scheme (e.g. 2 ends Umorfil PET yarns and 2 ends Umorfil Viscose yarns), the fabrics laundered using the detergent with optical brightener exhibited relatively better performance in terms of water vapor permeability and wicking, in particular.

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