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A Study of the Moisture Management Treatment on the Ultraviolet Protection Effect of Cotton Knitted Fabric

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Authors' contributions

This work was carried out in collaboration between all authors. Author Kan designed the study, arranged experiments in factory, and wrote the first draft of the manuscript. Author Lam managed the literature searches and analyses of the study. All authors read and approved the final manuscript.

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Short Communication

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ABSTRACT

This paper investigated the effect of moisture management treatment on the UV protection effect of cotton knitted fabric with different structures. UV measurement was carried out using a spectrophotometer in accordance with standard testing method and the results revealed that moisture management treatment would slightly affect the UV protection effect of cotton knitted fabrics.

Keywords: Moisture management; UV protection; cotton; knit.

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1. INTRODUCTION

Moisture management is a kind of chemical treatment which can enhance the hydrophilic properties of fabric to absorb more moisture with a better hand-feel (such as soft, bulky, smooth), better rate of overall comfort and a better drape and pliability [1]. In addition, this treatment can improve the sewability. Cotton fabrics treated with moisture management agent can increase their hydrophilicity so that the cotton fabrics can absorb more water and sweat from skin and transport to external environment. This action can enhance evaporation and dry-feeling with comfort. Recently, customers are more likely to wear this kind of hydrophilic garment with comfort hand-feel, especially during exercising and doing out-door activities. In summer time, during exercising and out-door activities, people would be expose to ultraviolet (UV) radiation under sunlight. Although the moisture management treated cotton fabrics can impart good comfort, its ability for UV protection for human being is seldom reported. Among different types of garment, knitwear is a commonly used garment in summer time [2-6]. Therefore, this study will investigate the effect of moisture management treatment on the UV protection effect of cotton knitted fabrics as well as their fabric structure.

2. EXPERIMENTAL DETAILS

2.1 Material Preparation

100% cotton knitted fabrics were obtained from a factory in China (Evo Green Technology Development Ltd.) and their specifications are shown in Table 1. The fabrics were well scoured and bleached.

The fabrics were dyed with reactive dyes using recipe below (violet in colour) Table 2 in a jet-dyeing under industrial condition and the fabrics were dyed at 60°C for 15 minutes. After dyeing, the fabrics were neutralized with acidic buffer (Acetic acid (98%): 1.6g/l; Sodium acetate: 0.8 g/l) to acquire a nearly neutral pH at 7.0 and finally washed by hot water at 97°C for three minutes and then washed by cold water for three minutes. Then the fabrics were dried completely and conditioned (temperature = 20±1°C and relative humidity = 65±2%) for 24 hours before moisture management treatment.

2.2 Moisture Management Chemical Treatment

Moisture management treatment was conducted under industrial condition with pad-dry-cure method. The fabrics were padded with below recipe (Table 3) with a wet pick-up at 100%. The pH value of padding solution was controlled by using malic acid at 5-6. Fabrics were completely dried at 100°C for 5 minutes and cured at 130°C for 3 minutes at a stenter.

2.3 UV Measurement

After moisture management treatment, all the fabrics were then stored in conditioning room with the temperature at 20±1°C and relative humidity at 65±2% for four hours before UV measurement. Three samples of size 3 x 3 inches were randomly cut from each treated fabric. UV measurement was carried out using Cary model 50 UV/VIS Spectrophotometer in accordance with AS/NZS 4399:1996 standard. Three measurements were made in course and wale directions the ultraviolet A (UVA) transmission, ultraviolet B (UVB) transmission and mean UPF were then calculated.

2.4 Moisture Regain

The moisture regain of the fabric was evaluated by ASTM D2495-07(2012) – Standard test method for moisture in cotton by oven-drying.

3. RESULTS AND DISCUSSION

Table 4 shows the UVA transmission, UVB transmission and UV protection factor (UPF) of the control and moisture management treated fabrics. The UV transmission and UPF can be used for describing the *In vitro* UV protection effect of a material. The control fabrics refer to the dyed fabric without moisture management treatment. According to Table 4, the UV protection properties of moisture management treated fabrics had less UVA and UVB protection than control and with very close UPF rating as control fabrics. The transmissions of UVA and UVB of moisture management treated fabrics were slightly higher than untreated fabric. That may because the moisture regains of fabrics were increased of average 5% after treatment that the presence of water could reduce the optical scattering effects and hence increase the UV transmission with the result of lower UV protection properties [7-10]. As a result, this moisture management treatment could slightly add the UV protection to fabrics.

Table 1. Fabric specifications

Fabric	Structure	Cotton number (Ne)	Fabric eight (g/m^2)	Thickness (mm)	Course per inch	Wale per inch
1	Single jersey	30	140	0.47	52	41
2	Single jersey	32	145	0.44	51	41
3	One-by-one rib	30	185	0.70	45	30
4	One-by-one rib	32	180	0.77	44	28
5	Interlock	40	190	0.77	45	41

Table 2. Dyeing recipe

Chemicals	Concentration (g/l)
Sumifix yellow 3RS	0.0007l
Sumifix red EF	0.0084l
Sumifix blue BRF	0.0022l
Sodium sulphate (99%)	10
Sodium carbonate (99%)	5.6

Materials-to-liquor ratio: 1:20

Table 3. Moisture management chemical treatment recipe

Chemical	Concentration (g/l)
Solusoft TOW (Hydrophilic silicon softener, weakly cationic)	40
Malic acid	0.5

Table 4. UV protection properties (95% confident level)

Fabric	UVA transmission (%)		UVB transmission (%)		UPF	
	Control	Moisture management treated	Control	Moisture Management treated	Control	Moisture management treated
1	7±0.3	8±0.4	9±0.4	10±0.5	15	15
2	8±0.4	9±0.5	8±0.3	9±0.4	15	15
3	5±0.2	7±0.4	6±0.3	7±0.4	40	35
4	5±0.3	5±0.3	6±0.3	7±0.4	40	35
5	3±0.2	3±0.1	3±0.1	4±0.2	50+	50+

When the fabric structure was compared, the single jersey structure generally gives the lowest UPF value while the rib and interlock structures give a better UPF value as shown in Table 2. The difference is that single jersey is a single knitted structure but the rib and interlock are double knitted structure. Generally speaking, double knitted structure would have better UPF than single knitted structure [11]. However, when rib and interlock structures are compared. Interlock is able to provide excellent UV protection because of the high fabric thickness, weight, density and tightness [12].

4. CONCLUSION

UV protection effect was measured for moisture management treated cotton knitted fabrics. Experimental results revealed that moisture management treatment would slightly reduce the UV protection effect due to the presence of water in the fabric. About 1-2% changes in the UVA and UVB protection. If the fabric structure was compared, the single jersey structure had lower UPF value than the rib and interlock structures.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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