Scientific Research and Essays Vol. 5(16), pp. 2169-2178, 18 August, 2010
Available online at http://www.academicjournals.org/sre
ISSN 1992-2248 ©2010 Academic Journals

Full Length Research Paper

Research of UV permeability properties of basic weft knitted structures

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Accepted 24 March, 2010

Sunlight is an indispensable life source for all organisms in the Earth. These rays arrive to the earth between 280 - 3000 nm wavelengths. Although, small doses of UV rays are useful for life, they cause effects such as sunburn, allergies, early aging in the skin, skin cancer, bruise formations and cataract on human body as far as this dose increases. These harmful effects are more seen in light skinned people. In this study the literature information was given concerning the definition of ultraviolet radiation (UVR) which is harmful sunlight's, the relation between UVR and textile materials, is the protection from ultraviolet rays through textiles and the development of ultraviolet protective properties of textiles. As an addition to this information, after applied optical bleach and dying process on 100% cotton basic weft knitting fabrics, 4% absorber chemical substance was applied to these fabrics. After applied different treatment processes to these fabrics of different construction and grams, the effect of construction and grams on UV permeability of basic weft knit fabrics and the effect of processes on UV permeability were searched experimentally, and the found values were examined by means of formed tables and graphics.

Key words: UVR, UPF, UV absorbent substance, weft knitting fabric.

INTRODUCTION

Ultraviolet radiation

The sun radiation on the earth composes of visible radiation (light), infrared radiation (heat) and ultraviolet radiation. Human eyes react to visible radiation and infrared radiation is felt on the skin as heat. Ultraviolet radiation is neither visible nor felt. So, the one which is more dangerous is ultraviolet radiation (Algaba and Riva, 2002). Ultraviolet radiation is a part of sun energy arriving to the earth. UV composes of about 5% of sun radiation arriving to the earth and the wavelengths are between 100 - 400 nm. UVR is classified in three ways as UVA, UVB and UVC (Mutlu et al., 2003).

UVA radiation (320 - 400 nm) causes the melanin formation in the skin, so, quick colourings which occur within a few hours and disappear after short time are seen. Nevertheless, UVA rays which cause the tissues to loose their elasticity by going forward to the regions under the skin, cause the cells to age early and cause wrinkles of the skin.

UVB radiation (280 - 320 nm) is more powerful than UVA radiation and it is much more harmful for eyes and skin than UVA. UVB rays make a few mms going forward in the skin and form pigment formations in skin cells for longer time according to the pigments UVA forms in the top layer of the skin. Moreover, excessive exposure to UVB causes result like the increase in the thickness of the skin and early aging of the skin. More important thing is that, it causes skin cancer and makes illnesses concerning immune system appear. Since, UVB radiation is absorbed by ozone layer, only its small amount arrives to the earth surface. UVC radiation (100 - 280 nm) is totally absorbed by ozone and oxygen in the atmosphere and cannot arrive to the earth surface. It is a type of radiation becoming most harmful for eyes and skin if it can arrive (Algaba and Riva, 2002; Palacin, 1997; Akaydin et al., 2009).

Relation between ultraviolet radiation and textile materials

That there are many health problems of the people exposed to ultraviolet radiation and that ozone layer

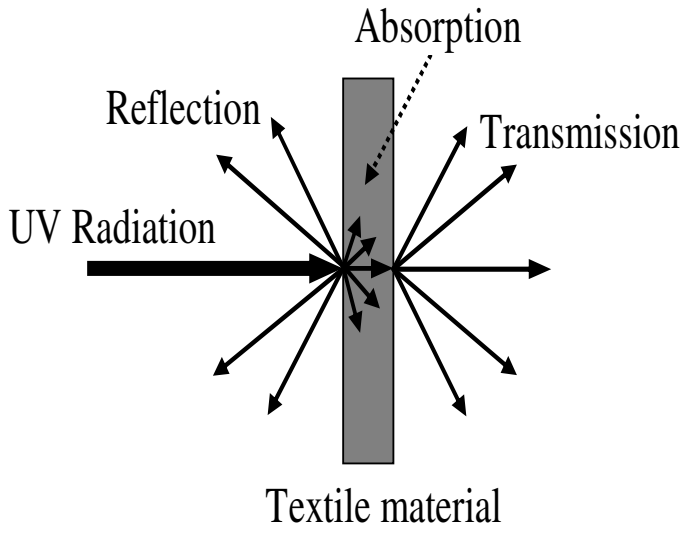

Figure 1. Reflection, absorption and transmission of UV radiation (Algaba and Riva, 2002).

around the earth becomes thinner day by day, bring along the necessity for the people to be protected from UV rays. So, the people working or taking place in open areas must protect themselves to decrease the effect of UV rays (Palacin, 1997). Protecting from the sun composes the combination of avoiding from sun, protective clothing and accessory use. Protecting against harmful rays of UVR can be provided through 3 different methods. These are shortening of exposing time to sunlight, using sun protection creams and use of protective clothing (Saravanan, 2007). Clothing is seen as a good way of protecting from sun but some of clothing is not enough to protect against UV radiation. Especially in hot seasons light and fine clothing are preferred. However, the effect of these types of clothing is lower in protecting against UV rays (Algaba and Riva, 2002).

A protection factor of a clothing, when compared with naked skin, shows the situation of how much a clothing protects the skin from sunlight and so the unavailability of erythema on the skin (Ayaz et al., 2001). The protection factor concept also provides the comparison of protective properties of different materials. This concept is useful in terms of stating numerically the protective effect of textiles and sunglasses against UV rays. By the aim of differentiating clothing and other textiles from sun creams, protection factor is known as UPF (Ultraviolet Protection Factor) having the same meaning the protection factor used in sun creams (SPF= Sun Protection Factor) (Palacin,1996). Protection grade a substance that provides against the side effects of sunlight is known as SPF (Solar Protection Factor). It is defined as the division of the beginning time of erythema (skin redness mostly appearing as spots due to the harm or irritation of the layer) forming with the use of protective substance into the beginning time of erythema occurring without protective substance (Algaba and Riva, 2002).

UPF is assessed with the minimum ray dose causing skin erythema for an unprotected skin as a function of spectral activity and wavelength, namely; from the proportion between effective UV ray dose and the sun's falling spectral energy distribution (Palacin, 1996). Ultraviolet Protection Factor is a criterion of the protection a fabric provides against ultraviolet rays. There are three factors in determining UPF of a fabric (Algaba and Riva, 2002). These are:

(i) Fabric's spectral transmittance: represents the energy amount passing through the fabric per wavelength.
(ii) Sun's spectral radiation: is a function of sun energy amount arriving to the earth surface per wavelength.
(iii)Erythema effect spectrum: is value spectrum of UV radiation effect on the skin per wavelength (Algaba and Riva, 2002).

The amount of the radiation passing out of materials is known as spectral transmittance. A small amount of radiation passes through the fabric without transmitting, but a great part of it transmits in the material and incoming ray beams reveal in a different direction (Figure 1). Both of transmitted and non-transmitted radiations are harmful for the skin and they should be taken into account in determining UPF. For this, measuring of UV radiation passing through the material both directly and transmittedly is necessary (Algaba and Riva, 2002; WEB-1, 2007; Akaydin et al., 2009).

Transmission spectrum

The thing being important for a textile surface's protection effect from the sun is transmission spectrum pertaining to the rays scattering in the UV region. UV rays spilling on the textile surface change spectral ray content occurring in fiber material by means of absorption. This change in the absorption of fiber material is sourced from its chemical content (what kind of fiber), possible additives inside the fiber (for example matting pigments) and the storage of materials in different structures (dyestuffs). Transmission spectrums and also SPF values of woven or knitted fabrics are peculiar to themselves (Reinert et al., 1996; Reinert et al., 1994).

In contrast of general acceptances, summer clothes provide a low protection against UV rays. Cotton and PES/Cotton based woven fabrics which are mostly used fiber types for these kinds of clothes have a protection factor under 15. This value is lower than the expected one from a classical sun cream. In woven and knitted fabrics, the factors affecting the permeability of UV rays are those (Algaba and Riva, 2002; Haerri et al., 2001; Haerri, 2000):

(i) Fibers in the combination of the fabric: the structure of

Table 1. Construction properties and machine information of the fabrics used in the research.

Fabric and yarn information		Raw fabric values				Machine information		
Fabric type	**Yarn type (Ne)**	**Grams (g/m^2)**	**Frequency (may/cm)**	**Diameter (Ø)**	**Fine (E)**	**Trademark**	**Model**	**Number of needle**
RL-Jersey	30/1Carded	105	15	30"	28	Keumyong	KM 3WV4T	2640
RL-Jersey	30/1 Carded	127	21	30"	28	Keumyong	KM-3WV4T	2640
RRRibbed	30/1 Carded	126	13	14"	16	Mayer and Cie	FV-2.0	708
RRRibbed	30/1 Carded	135	15	14"	16	Mayer and Cie	FV-2.0	708
RRInterlock	40/1 Carded	145	14	30"	24	Keumyong	KILM-84AV	2256
RR-Interlock	40/1 Carded	165	19	30"	24	Keumyong	KILM-84AV	2256

fibers used as raw material in the fabric is a factor affecting that fabric's UV permeability (Palacin, 1997). According to some researchers, while untreated cotton, silk, polyamide and acrylic fibers provide a little UV absorption, wool provides good absorption in whole UV spectrum.

(ii) Additives of fibers comprise: Some regenerated and synthetic fibers unit with the productions which absorb and reflect UV radiation. Titanium dioxide is very suitable for this function together with barium sulphate, zinc oxide and other pigments.

(iii) Structural properties of fabric: The combination of the fabric's structural properties (weave type, fiber type and number, thread frequency etc.) has great effect on thickness, weight, porosity of the fabric and so on, in the transmission of UV radiation from the fabrics. Loose structured fine fabrics provide lower protection effect than dense woven fabrics.

(iv) Colour and colour violence: Dyestuffs used in textile industry absorb visible radiation (400 - 700 nm) differently. Absorption area for such dyestuffs can extend up to UV wavelengths and so these dyestuffs are known as UV absorbers. However, the provided protection amount varies based on colour intensity and each dyestuff's chemical structure.

(v) Presence of optical bleach substances: These are compounds absorbing radiation from UV spectral area and retransmitting radiation in visible area and so called UV absorbers.

(vi) Some finish process materials: UV absorbers or UV inhibitors are colourless compounds which absorb radiation in ultraviolet spectral region.

(vii) Washing/drying conditions of clothes: The protection of the fabric provided can change with the use of clothes. Squeezing, becoming feathered (fluff) and the use of optical bleach substances in detergent manufacture are the factors affecting UV radiation transmission of textile products.

(viii) Stretching: Stretching of a fabric can cause a decrease in UPF ratio. This is widespread in knitted and elastic fabrics, so that, the people wear clothes being suitable for their bodies is important. If a person wears a tight dress according to his body, the dress will open more and so provide lower protection against ultraviolet rays.

(ix) Damp ratio: Many fabrics have lower UPF when they are damp. The water located in the voids of the fabric decreases the refraction of the light and so the permeability of the fabric increases. Lowness in UPF value varies depending on the type of the fabric and the amount of damp it absorbs when it is wet (Ayaz et al., 2001; Akaydin et al., 2009).

Textile materials and UV protection

Different physical events can occur by the effects of UV rays on textiles, like that on the glass (Reinert et al., 1996; Reinert et al., 1994). Some part of UV rays dropping on textile materials reflect, some part is absorbed and some part passes through fibers and voids and pores (Saravanan, 2007). Rays can be reflected on the surface without imposing into the textile materials or by passing through inside but without coming out. However, rays can be totally absorbed especially by tight and heavy textile manufactures. In both situations, there is no UV ratio on the skin (Rieker and Guschlbauer, 1999).

Another physical event on the rays created is the linear (linear transmission) penetration of UV rays particularly into the big pore structured textile. Often occurring situation is the scattering of rays after penetration in normal structured textile materials. In both situations, UV rays have more or less effect on the skin (Rieker and Guschlbauer, 1999). Nevertheless, it varies according to the skin type, sun rays and textile material, when the time of exposure to the sun (UV rays) is long enough; sunburns can form under the fabric as well. However, it must be taken into account that the skin harms can occur without visible sunburn. Due to the memory effect of the skin, these harms can show themselves as aging and skin cancer (Algaba and Riva, 2002).

MATERIALS AND METHODS

In this study, RL-jersey, RR-ribbed and RR-interlock knit constructions, which were knitted with the use of 100% cotton yarn,

Table 2. Performance tests applied in the study and standards.

UV permeability and protection factor test	AS/NZS 4399:1996
Fabric grams test	TS 251/February 1991
Texture (thread density) test	TS 250 EN 1049-2/February 1996

were used. Physical properties and machine values of the fabrics used in the study were shown in Table 1.

In the next parts, jersey the raw gram of which is 105 g/m^2 will be called RL-Jer 1 (jersey in low grams), 127 g/m^2 jersey RL-Jer 2 (jersey in high grams), 126 g/m^2 rib knit RR-Rib 1 (rib knit in low grams), 135 g/m^2 rib knit RR-Rib 2 (rib knit in high grams), 145 g/m^2 interlock RR-Int 1 (interlock in low grams) and 165 g/m^2 interlock RR-Int 2 (interlock in high grams).

These fabrics used in the study were first treated with pre-treatment processes as hydrophilization (pre-treatment with sodium hydroxide and hydrogen peroxide) and optical bleach. The study prescriptions, pertaining to hydrophilization and optical bleach are thus given.

Hydrophilization prescription

3 g/l sodium hydroxide
3 g/l hydrogen peroxide
1 g/l moisturizer

Optical bleach prescription

3 g/l sodium hydroxide
3 g/l hydrogen peroxide
1 g/l moisturizer
0.1 g/l optical whitener

After both processes, the fabrics were rinsed and brought to pH 5 - 5.5 and given enzyme and peroxide on them was made inactive-neutral. After the treatment with enzyme, washing and rinsing operations were made. The fabrics hydrophilized were dyed with reactive dye-stuffs pertaining to the same dye group according to the exhaust method. Dying prescription of the used dyes are given thus.

Dying prescription

Everzol	Yellow	3RS	1.3%	Salt = 7 g (NaCl)
Everzol	Red	3BS	1.1%	Sodium bicarbonate = 1 cc
Synozol	Blue	KR	0.14%	Sodium hydroxide = 0, 12 cc
				Liquor ratio = 1/10

After finished dying operation, neutralization operation was made with acetic acid at cold. After neutralization, washing and rinsing operations were made again. UV absorbent substance was applied in 4% ratio to the dyed fabrics and optic bleach applied fabrics. Rayosan C Paste chemical pertaining to the Clariant firm was used as UV absorbent substance.

UV permeability values of 12 different fabric samples, into which absorbent substance was added, which were both optical bleached and dyed and in different structure and grams, were measured in SDL ATLAS M284 device. UV permeability values between 290 - 400 nm wavelengths that were got from the device, UPF values, graded UPFs and permeability values in UVA and UVB of the samples were found and the relations among them were examined through tables and graphics. All performance tests made concerning fabrics were realized in TS 240 standard atmosphere conditions (20 ± 2°C and 65 ± 2% humidity). Performance tests applied to the fabrics in the study and standard methods were shown in Table 2.

RESULTS AND DISCUSSION

First, after both optical bleach operation and also dying operation, % transmittance values of 100% cotton knitted fabrics of different structures, 4% absorbent substance was applied between 290 - 400 nm wavelengths, were determined and after that, their UV permeability, UPF values, graded UPF values and UV permeability in UVA and UVB regions were measured according to AS/NZS 4399:1996 standard.

Effect of construction and grams on UV permeability of fabrics

The effects of construction and grams on UV permeability of knitted fabrics of different grams and constructions, on that hydrophilization process was applied, between 290-400 nm wavelengths were given in Table 3, 4 and Figure 2.

When the above Table 3 and Figure 2 are examined, it is seen that transmittance values of hydrophillized knitted fabrics of different grams and constructions are from the top to the low in RL Jersey, RR Ribbed and RR Interlock fabrics respectively. As expected again, the highest transmittance value is seen in RL Jer 1 and the lowest value in RR Int 2. However after 340 nm wavelength, that interlock (RR Int 1) fabric of low grams reached higher transmittance value than Ribbed fabric which had high collection property transversely is also remarkable. So that fabrics have high density and grams values together with their good construction properties is important for transmittance.

UPF, graded UPF, permeability in UVA and UVB regions of hydrophillized knitted fabrics of different grams and constructions were given in Table 4.

When the values in Table 4 are examined, it is seen decrease in UV permeability values and increase in graded UPF values with the increase of grams. It is seen that the construction conducting UV rays at the least is interlock and the construction conducting UV rays at the most is jersey.

Effect of processes on UV permeability of fabrics

4% UV absorbent substance was applied to the fabrics of

Table 3. % transmittance values of knitted fabrics of different grams and constructions, on that hydrophilization process was applied, between 290-400 nm wavelengths.

Wavelength (nm)	% Transmittance					
	RL- Jer 1	RL-Jer 2	RR-Rib 1	RR-Rib 2	RR-Int 1	RR-Int 2
290	16.7515	11.0385	13.0785	12.6625	7.4475	4.0235
295	18.52	12.594	13.5535	13.2005	8.7145	4.866
300	20.072	14.014	13.9395	13.6645	9.911	5.6955
305	21.5745	15.439	14.341	14.1435	11.1645	6.591
310	22.918	16.7235	14.7265	14.614	12.2375	7.4585
315	23.9215	17.7095	15.079	15.008	13.091	8.16
320	24.902	18.8565	15.755	15.803	14.1225	8.927
325	25.763	19.7465	16.1845	16.2915	14.9325	9.591
330	26.563	20.5595	16.649	16.8375	15.676	10.2565
335	27.4345	21.4585	17.1335	17.4045	16.509	10.9925
340	28.5785	22.6955	17.654	18.037	17.647	12.0065
345	29.5525	23.726	18.246	18.703	18.6265	12.932
350	30.2705	24.517	18.7495	19.305	19.392	13.6655
355	31.0185	25.3755	19.3355	20.0005	20.215	14.4645
360	31.8305	26.2645	19.9955	20.8285	21.059	15.3115
365	32.4815	26.9815	20.5585	21.481	21.7565	16.013
370	33.1305	27.695	21.1815	22.2235	22.467	16.7475
375	33.815	28.49	21.877	23.066	23.226	17.559
380	34.3355	29.075	22.4405	23.8575	23.8415	18.251
385	34.763	29.577	22.9635	24.487	24.315	18.8055
390	35.3315	30.2405	23.661	25.3325	24.9555	19.5275
395	35.8385	30.8315	24.296	26.1365	25.5265	20.2135
400	36.0875	31.105	24.625	26.5625	25.8075	20.5975

Table 3's transformed state into linear graphic is like Figure 2.

Table 4. UPF values of knitted fabrics of different grams and constructions and some parameters depending on this.

Samples	UPF value	Graded UPF	Permeability in UVA region	Permeability in UVB region
RL-Jer 1	4.86	0	28.3	18.8
RL-Jer 2	6.54	5	23.1	13.5
RR-Rib 1	6.98	5	19.5	13.3
RR-Rib 2	7.07	5	18.8	13.2
RR-Int 1	8.95	5	18.3	9.3
RR-Int 2	14.7	10	12.3	5.4

different constructions and grams after optical bleach and dying operation were applied. % transmittance values of these fabrics between 290 - 400 nm which is UV radiation wavelength space were shown in Tables 5 - 8 and Figures 3 and 4. Transmittance values of basic weft knitted fabrics of different constructions and grams, on that hydrophilization, optical bleach and after that, 4% UV absorbent substance were added, as expected. In this situation, the fabric construction having the highest transmittance property is RL Jer 1 and the fabric construction having the lowest transmittance property is RR Int 2. It was seen that, there are decrease in transmittance values with the increase in grams and fabric density.

When Table 6 is examined, it was seen that, especially UPF value of RR Int 2 fabric is the highest and the protection values in UVA and UVB regions are quite high. This situation is sourced from the construction property of interlock knit peculiar to it. If RR ribbed fabric is knitted densely enough and in enough grams and also if the property of collection and shortening expected from itself

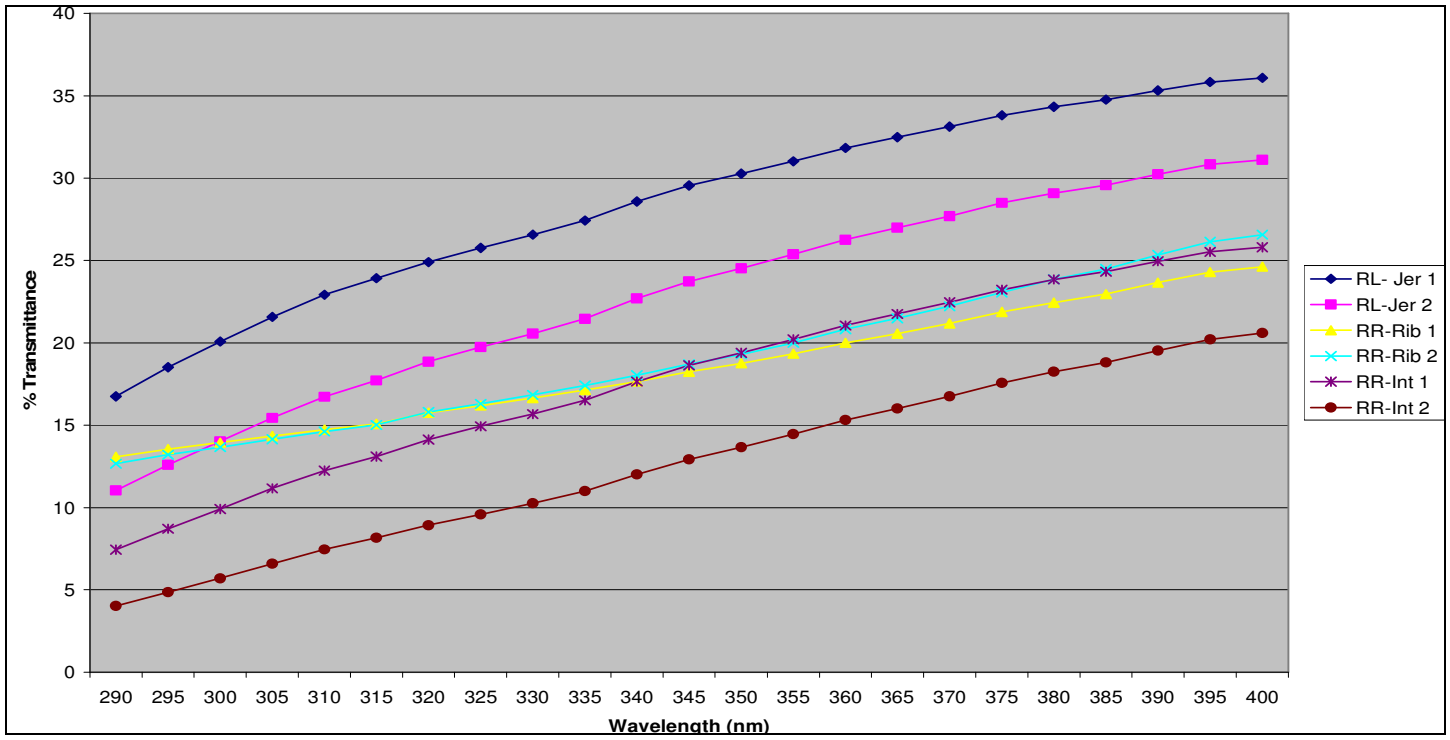

Figure 2. % transmittance values of knitted fabrics of different grams and constructions, on that applied hydrophilization process was applied, between 290-400 nm wavelengths.

Table 5. % transmittance values of 100% cotton knitted fabrics, which have optical bleach +4% UV absorbent substance and different constructions, between 290-400 nm wavelengths.

Wavelength (nm)	% Transmittance					
	RL-Jer 1	RL-Jer 2	RR-Rib 1	RR-Rib 2	RR-Int 1	RR-Int 2
290	1.92	1.0845	0.844	0.538	0	0
295	2.17	1.2345	0.9245	0.593	0.0085	0
300	2.62	1.5315	1.0805	0.712	0.047	0
305	3.51	2.127	1.392	0.9555	0.141	0
310	4.74	3.0505	1.8715	1.386	0.2835	0
315	6.17	4.149	2.4755	2.006	0.4735	0.078
320	7.96	5.859	3.5015	3.072	0.9525	0.3415
325	9.28	6.85	4.3715	4.117	1.4885	0.5595
330	10.03	7.303	5.0195	4.8335	1.944	0.8685
335	10.10	7.235	5.2305	4.9935	2.1285	1.066
340	9.76	6.857	5.123	4.7915	2.0735	1.129
345	9.31	6.47	4.9	4.4845	1.925	1.083
350	8.90	6.149	4.6785	4.2045	1.769	1.009
355	8.51	5.841	4.4565	3.929	1.621	0.9265
360	8.29	5.681	4.3345	3.794	1.553	0.8875
365	8.32	5.7105	4.3515	3.8225	1.567	0.908
370	8.43	5.798	4.429	3.9035	1.6255	0.959
375	8.60	5.959	4.55	4.058	1.7425	1.0655
380	8.89	6.2095	4.671	4.256	1.7595	1.0465
385	9.73	6.892	5.177	4.889	2.097	1.288
390	11.06	7.9475	6.0085	5.916	2.6905	1.737
395	12.34	9.0045	6.8725	6.961	3.3605	2.2745
400	13.10	9.68	7.415	7.63	3.805	2.64

Table 5's transformed state into linear graphic is like Figure 3.

Table 6. UPF values of the fabrics having optical bleach +4% UV absorbent substance of different constructions and some parameters depending on this.

Samples	UPF value	Graded UPF	Permeability in UVA region	Permeability in UVB region
RL-Jer 1	23.6	15	8.9	3.1
RL- Jer 2	35.7	30	6.3	1.9
RR-Rib1	54	45	4.6	1.2
RR-Rib 2	69.9	50	4.2	0.9
RR-Int 1	292.6	50	1.7	0.1
RR-Int 2	876.5	50	1	0

Table 7. % transmittance values of 100% cotton knitted fabrics having dark color +4% UV absorbent substances of different constructions between 290-400 nm wavelengths.

Wavelength (nm)	% Transmittance					
	RL-Jer 1	RL-Jer 2	RR-Rib 1	RR-Rib 2	RR-Int 1	RR-Int 2
290	0.91	0.769	0.709	0.4615	0	0
295	0.93	0.775	0.71	0.4715	0	0
300	0.98	0.794	0.7305	0.492	0	0
305	1.08	0.8455	0.787	0.5405	0.054	0
310	1.24	0.93	0.88	0.6115	0.1285	0.015
315	1.39	1.0085	0.9685	0.683	0.1425	0.038
320	1.54	1.1715	1.1655	0.809	0.2425	0.186
325	1.61	1.192	1.19	0.822	0.237	0.173
330	1.69	1.21	1.197	0.8515	0.229	0.142
335	1.74	1.2195	1.219	0.8635	0.241	0.123
340	1.79	1.256	1.254	0.9025	0.24	0.121
345	1.86	1.28	1.279	0.931	0.2465	0.1185
350	1.86	1.2755	1.282	0.9365	0.244	0.108
355	1.82	1.253	1.251	0.9085	0.232	0.1045
360	1.76	1.2225	1.2235	0.877	0.2295	0.1105
365	1.71	1.2025	1.205	0.8585	0.2215	0.1105
370	1.70	1.2125	1.2065	0.864	0.236	0.154
375	1.75	1.2815	1.285	0.933	0.306	0.2225
380	1.60	1.1495	1.1535	0.7995	0.1855	0.069
385	1.59	1.1525	1.149	0.7955	0.186	0.088
390	1.60	1.1625	1.1625	0.8115	0.2195	0.1305
395	1.65	1.21	1.2085	0.8605	0.265	0.184
400	1.69	1.2625	1.265	0.9175	0.3175	0.2375

Table 7's state transformed into linear graphic is like in Figure 4.

is high, then the protection value especially in UVB region can be high. It cannot be said that the protection value of RL Jersey fabric knit in low grams are sparsely high. Even if we would prefer this fabric structure in terms of cost, we should prefer the fabrics being in a suitable density and grams.

Transmittance values of basic weft knitted fabrics of different constructions and grams on that hydrophilization, dying and after that, 4% UV absorbent substance were added has shown in Table 7 and Figure 4. As in optical bleached fabrics, the fabric construction has the highest transmittance property of RL Jer 1 and the fabric construction having the lowest transmittance property of RR Int 2. RR Int 1 fabric is also in quite low transmittance value. In the graphic RL Jer 2 fabric and RR Rib 1 fabric gave quite similar values. The explanation of this is that, grams of the fabric are as important as construction.

When transmittance values of optical bleached fabrics in Figure 3 are compared with transmittance values of dyed fabrics in Figure 4, it was noted that transmittance values of dyed fabrics are much lower. The meaning of this is that dyed fabrics show more protective property

Table 8. UPF values of the fabrics having dark color +4% UV absorbent substances of different constructions and some parameters depending on this.

Samples	UPF value	Graded UPF	Permeability in UVA region	Permeability in UVB region
RL-Jer 1	93.5	50	1.6	1
RL-Jer 2	128.2	50	1.1	0.7
RR-Rib 1	131.3	50	1.1	0.7
RR-Rib 2	188	50	0.8	0.5
RR-Int 1	2335.2	50	0.2	0
RR-Int 2	5662	50	0.1	0

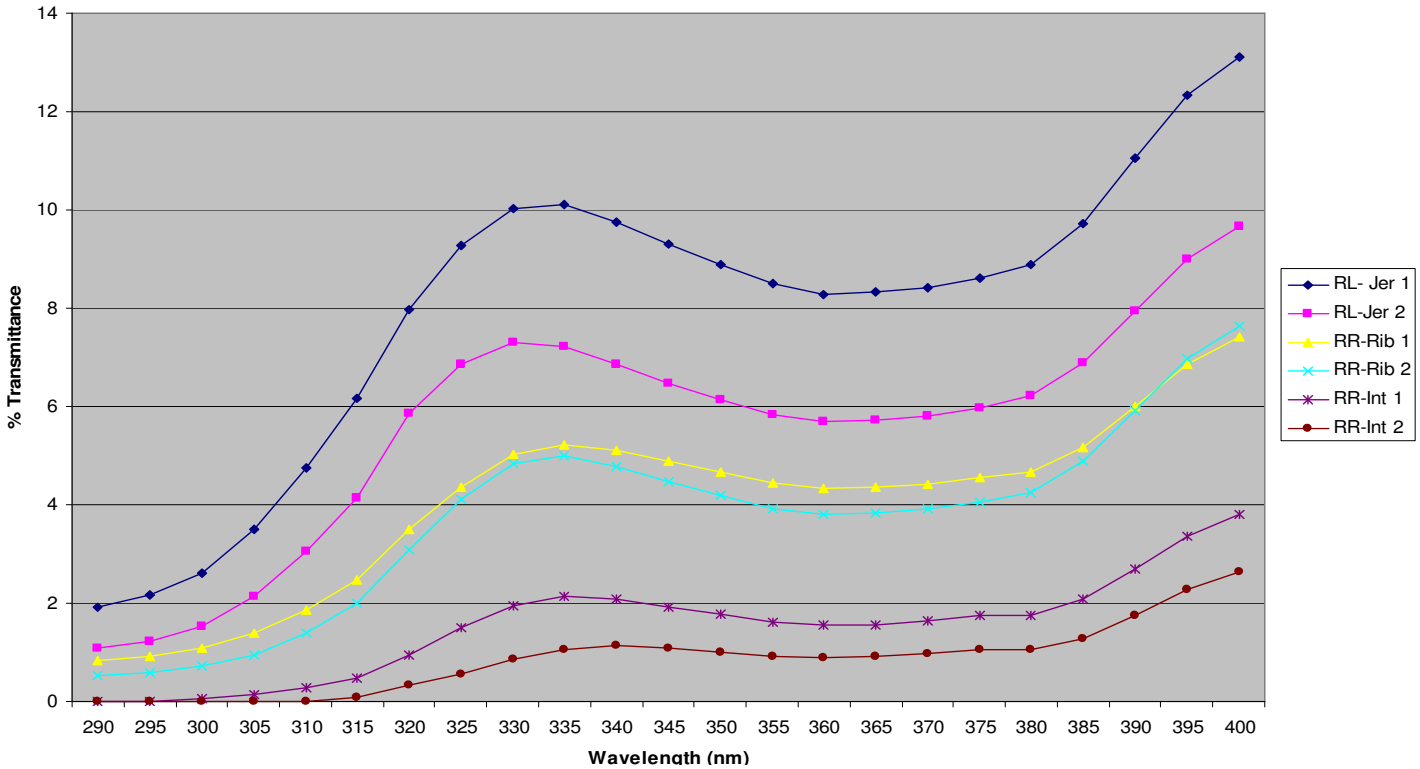

Figure 3. % transmittance values of 100% cotton knitted fabrics, which have optical bleach +4% UV absorbent substance and different constructions, between 290-400 nm wavelengths.

than optical bleached fabrics. When the values in Table 8 are examined, it is observed that, if enough UV absorbent substance is applied to basic weft knitted fabrics dyed in dark colour, these fabrics can show high protection properties against UV rays.

CONCLUSIONS

Result of experimental studies and measurements

(i) In the result of processes applied in the study to the fabrics of different grams and constructions, the fabric of the highest UPF, namely; the lowest permeability can be lined as the fabric dyed in dark colour and 4% UV absorbent substance applied fabric, optical bleached and 4% UV absorbent substance applied fabric and optic bleach applied fabrics, respectively.

(ii) According to grams and constructions, if we look at UPFs of fabrics, it was observed that UPF values increase as far as fabric grams increase. When interlock knit fabric was dyed and UV absorbent substance was given, that direct “perfect” category forms and it provides more protection according to other constructions can be explained as the differences of interlock knit fabric in basic weft knit construction according to other two constructions.

(iii) In the result of the study made by the aim of seeing

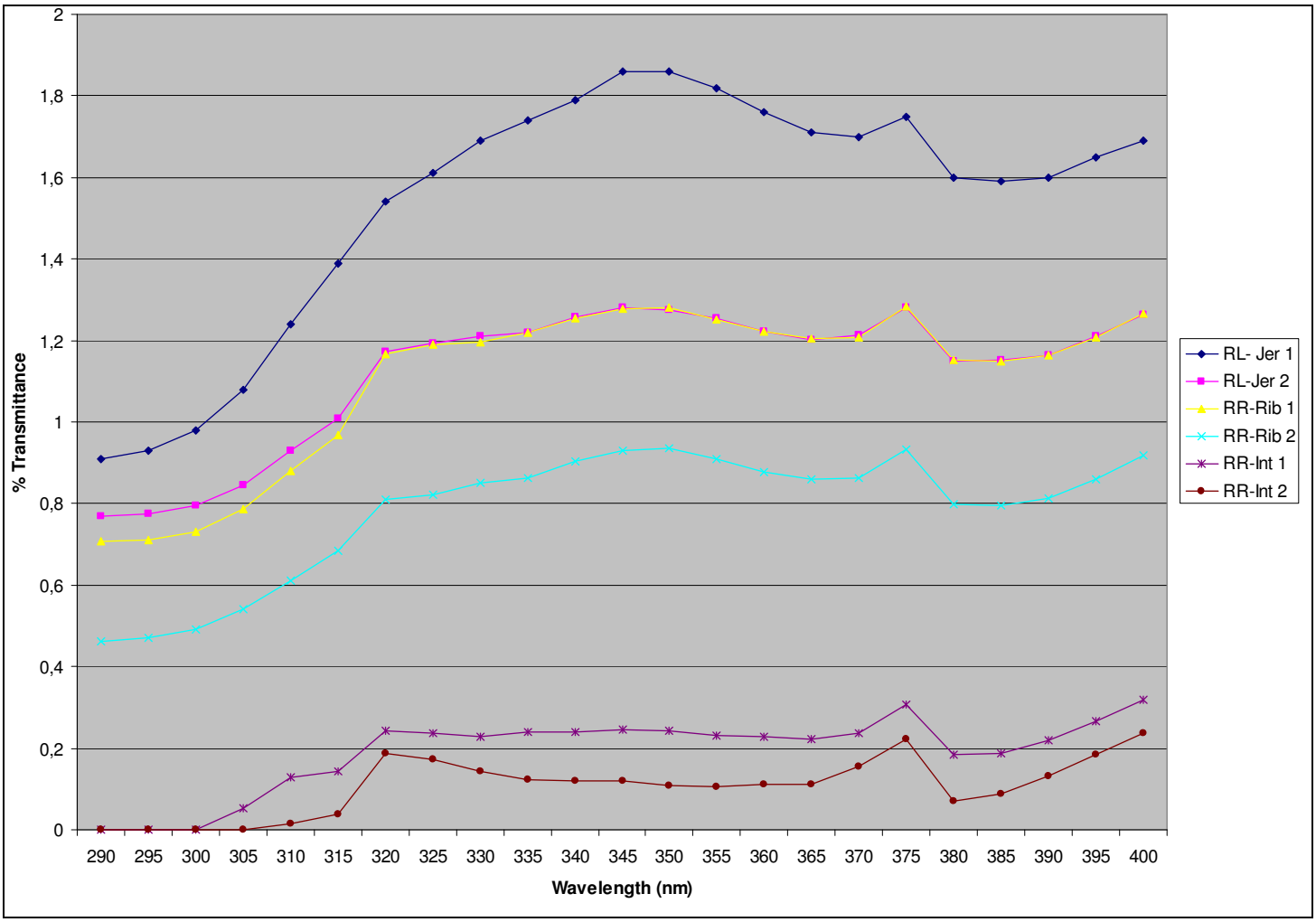

Figure 4. % transmittance values of 100% cotton knitted fabrics having dark color +4% UV absorbent substances of different constructions between 290-400 nm wavelengths.

the effect of the colour on UV permeability, it has been seen that UV protective properties increase with dying of fabrics and permeability decreases. The protection of dark coloured fabrics is better than light ones. If the wanted UV protection property is under expected when the fabric is dyed, UV protection of fabrics can arise to higher protection categories by applying UV absorbent substance.

(iv) With this study, they thought that, it is necessary to wear light coloured or white in the summer has changed a little. If we want to be protected from harmful UV rays, dark colours should be preferred. Those dark colours also increase the body heat which has revealed the fact that, the use of light coloured fabrics given UV absorbent substance will be more appropriate.

(v) In order to be protected from harmful rays, it is also necessary to pay attention to the fabric constructions. The protection of interlock fabric against UV rays is quite high to strengthen the opinion that makes more researches on this knitted fabric construction to be useful.

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