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RESEARCH ARTICLE

DEVELOPMENT OF UV PROTECTIVE FINISH ON COTTON KNITTED FABRIC

***,[1]Dr. Vandana Gupta and [2]Saloni Gupta**

[1]UIFV Department, Chandigarh University, Gauran, Mohali (140 413)
[2]Department of Environmental Science and Engineering, Guru Jambheshwar University of Science and Technology, Hisar, Haryana

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ABSTRACT

Textiles and clothing are the most suitable interface between environment and human body. It can reflect, absorb and scatter solar wavelengths, but literature sources claim that, it does not provide full sun screening properties. The present work was conducted to develop UV protective fabric and evaluate the ultraviolet protection factor by comparing the finished with unfinished fabrics. *Syzygium cumini* (L.) leaves extract was applied on cotton knitted fabric by using pad-dry cure process. The results indicated that finished cotton knitted fabric provides excellent UV protection with decrease in UVA and UVB percent transmissions, when compared with unfinished fabric.

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INTRODUCTION

In recent years, there is a drastic increase in the temperature of tropical region, due to which consumers have become increasingly aware of the need for sun protection, which is related to the incidence of sun induced skin damage and its relation with increased exposure to UV light. UV radiation amounts to about 6% of solar radiation and consists of UV-A (330-400 nm), UV-B (290-320 nm) and UV-C radiation (220-280 nm). Exposure to UV rays can cause not only sunburn but also premature skin ageing, skin cancer and eye disorders (Holme, 2003). Ren and Sha, 2012 noted the growing trend among consumers about relying on clothing for protection from ultra- violet rays. Studies reveal that favorite fibers like cotton, rayon, flax are the poorest UV absorbers, as compared to polyester, wool, silk and nylon (Crews *et al*., 1999). As a result, researchers are developing UV protective agents to further enhance the textile's ability to protect the wearer from harmful rays. Now–a-days with more environmental consciousness and more health problems associated with the use of synthetic products, consumers are looking for products developed through natural sources such as plants. Gupta *et al.,* 2005 reported good UV protective property of textile when dyed with *Q. infectoria* plant.

Corresponding author: Dr. Vandana Gupta
UIFV Department, Chandigarh University, Gauran, Mohali (140 413)

The present study has been conducted to develop UV protective finish by using a natural source (*Syzgium cumini* L.*)* which has not been explored before for the application on textiles as UV protective agent and natural UV-protective coatings can have advantage of sustainable fashion with less environmental impact.

MATERIALS AND METHODS

Material used

With the purpose to develop UV protective fabric, various chemicals/auxiliaries such as methanol (solvent), Palkascour (scouring agent), Fixa prêt Eco (cross-linking agent), Magnesium chloride (catalyst) and 100% cotton knitted was procured in greige form, from the industry.

Preparation of *S. cumini* (L) leaves extract

Fresh, mature leaves of *S. cumini* (L.) (jamun) was collected, washed and shade dried. The dried leaves were grounded in powder form by using an electric grinder. Powder was then subjected to hot methanolic extraction by using soxhlet extraction process, as described by Choudhary *et al.,* 2012 with slight modification.

Enzymatic scouring

Enzymatic scouring was carried out by treating fabric with 2% enzyme (pectinase), 1:20 material to liquor ratio at pH 8 for 45 minutes at 40^0 C. After the treatment, the fabrics were thoroughly rinsed with hot water followed by cold water and then dried at 80^0 C using hot air oven (Ragendran *et al*., 2011). This pre-treatment was given to greige knitted cotton fabric was to remove impurities and other fugitive color.

Application of finish

Ultraviolet protective finish was applied by using pad-dry-cure process on cotton fabric with *S. cumini* (L.) leaves extract. The sample was immersed in finishing solution containing 1:15 material to liquor ratio with 11% (owf) concentration of *S. cumini* (L.) leaves extract, 40g/l resin cross linking agent (fixa prêt eco), 10g/l magnesium chloride, at pH 5 for 30 minutes. Fabric was then passed between the rollers of padding mangle at 2 kg/cm^2 pressure to give a wet pick up of its maximum take up. The fabric was dried and cured in curing chamber.

Quantitative Assessment of Ultraviolet Protection Factor (UPF)

To determine the ultraviolet radiation blocked or transmitted by fabric intended to be used for UV protection, UVR TRANSMISSION AATCC-183:2004 test method was used. The transmission of ultraviolet radiation (UV-R) was determined in the wavelength range of 280-400nm by using Compsec M 350 UV-Visible Spectrophotometer. UVA and UVB percentage transmission was also measured. Ultraviolet protection factor was calculated using mean percentage transmission in UVA region (320-400 nm) UVB region (280 - 320 nm) according to the following equation:

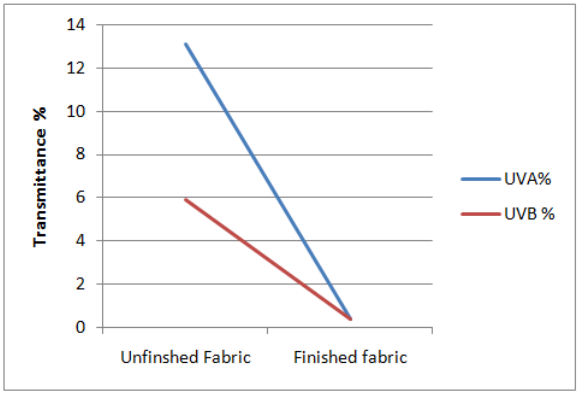
$$UPF = \frac{\sum_{\lambda\,290}^{400} E\lambda \; x \; S\lambda \; x \; \Delta\,\lambda}{\sum_{\lambda\,290}^{400} E\lambda \; x \; S\lambda \; x \; T\lambda \; x \; \Delta\,\lambda}$$

Where:

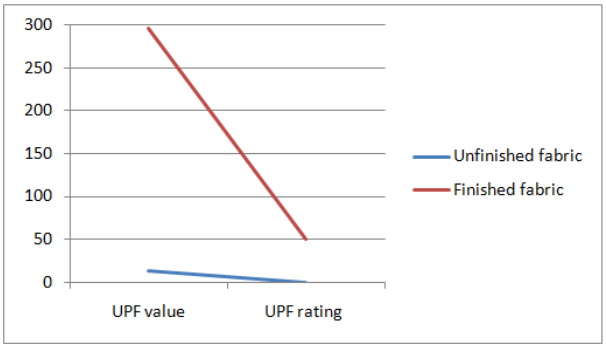
Eλ = relative erythermal spectral effectiveness
Sλ= solar spectral irradiance
Tλ= average spectral transmission of the specimen
Δλ= measured wavelength interval (nm)

RESULTS AND DISCUSSION

UPF is the scientific term used to indicate the amount of Ultraviolet (UV) protection provided to the skin by fabric. The higher the value, the longer a person can stay in the sun until the area of skin under the fabric becomes red (Dhandapani and Sarkar, 2007). According to experts, including the U.S. Environmental Protection Agency, the technique that best protects the skin against UV radiation is clothing (U.S. Environmental Protection, 2006). Fabrics with UPF value greater than 40 are considered as having excellent UV protection, whereas fabrics with 25-39 translates to have very good UV protection and fabrics with UPF values between 15-24 gives good UV protection.



Graph 1. UVA & UVB transmission of unfinished and finished fabrics



Graph 2. UPF value and UPF rating of unfinished and finished fabrics

Table 2 indicate the UVA, UVB percent transmission, UPF values and UPF rating of finished and unfinished knitted fabrics. As indicated from the results, fabric finished with *S. cumini* (L.) leaves extract exhibit better UV protection (296.2 UPF value) as compared to unfinished fabric (13.9 UPF value). The UVA and UVB percent transmission is also discussed, as UVA and UVB radiation provides harmful effect on skin; UV-A can penetrate the top layer of skin, thereby damaging the inner layers.

Table 1. Grades and Classification of UPF

UPF Range	UVR transmission %	Protection category
15 to 24	6.7-4.2	Good protection
25 to 39	4.1-2.5	Very good protection
40 to 50	<2.5	Excellent protection

Table 2. Ultraviolet protection Factor of the unfinished and finished fabrics

S. No	Sample	Ultraviolet Protection Factor (UPF) (AATCC-183:2004)				
		UVA%	UVB%	UPF Mean (value)	UPF rating	Protection category
1.	Finished	0.38	0.37	296.2	50+	Excellent
2.	Unfinished	13.21	5.88	13.9	No rating	Poor

UV-B radiation can cause sunburn and is thought to be the major reason for skin cancer as it inhibits the synthesis of DNA, RNA and proteins (Holme, 2003). The change in the UVA and UVB percent transmission in finished fabric as shown in graph 1 reveals that less UVA and UVB radiation is transmitted through it and thus finished fabric exhibit high UPF rating and protection.

Conclusion

The result of this study demonstrate that cotton which is most versatile and preferred fabric for summer exhibit no UV protection. Natural plant material i.e. *S. cumini* used as finishing agent, when applied on cotton knitted fabric enhances the ability of fabric to protect from UV radiations, thus increasing its performance property and increase its use in textiles used for sports and other outdoor activities. Thus providing healthy life style to the consumer.

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