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Impact of Fabric Density, Color and Composition of Plain Weave Fabric on Ultraviolet Protective Factor

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Keywords: *fabric density, composition, color, fabric weight, ultraviolet protective factor.*

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I. Introduction

Skin disease including skin cancer has become very common now a days. UV radiation from sun is the primary cause for skin cancer according to many researchers [1, 2]. Sun radiation has a continuous energy spectrum radiates from sun in the wavelength range of about 0.7 nm to 3000 nm. Only 280 nm to 3000 nm solar radiation can reach on the earth surface [3], where the wavelength of the ultraviolet spectrum lies between 290 nm to 400 nm. Overexposure to UVR has the most adverse impact onerythema and skin cancer, which increased the public awareness of adopting personal UV protective schemes such as the use of sunscreen on the exposed parts of body [4]. Besides using sunscreen and shading, people can also cover their body by wearing textile garments to protect from UVR [5, 6, 7]. But before selection of garments the fabric parameters like fabric density, color, weight should be considered to get better UV protection. I. M. Algaba, Achwal, B. R Daset al. showed the effect of thickness and weight on UV protection of cellulosic woven fabric [8, 9, 10]. Moon and Pailthorpe found that stretching elastane-based garments have lower UPF than unstretched garment [11]. To make a comparison of the ultraviolet protection factor of different composition, weight and color plain fabric is the aim of this study.

II. Material and Method

Two color black and red 100% cotton and 60% cotton 40% polyester plain fabric of different ends per inch, picks per inch collected from Evince limited. Then the samples are conditioned at relative humidity 65±2%, Temperature 20±2^{0}C at least 24 hours.

UPF Measurement: In this study, ultraviolet protective factor (UPF) represented the UV protective capabilities of woven fabrics from sunburn as a quantitative indicator. UV protection ability of cotton and blended plain fabrics measured by vitro approach. Ultraviolet protection factor in the vitro measurement conducted with a spectrophotometer in accordance with the AS/NZS 4399 standard.

Following is the equation of calculating UPF:

$$\text{UPF} = \frac{\sum_{290}^{400} E_\lambda S_\lambda \Delta_\lambda}{\sum_{290}^{400} E_\lambda S_\lambda T_\lambda \Delta_\lambda}$$

Where,
E_λ is the erythemal spectral effectiveness.
S_λ is the solar spectral irradiance (in W·m−2·Nm−1).
T_λ is the spectral transmission through the textile.
Δ_λ is the bandwidth (in nm).
And λ is the wavelength (in nm) [12].

The current Australian/New Zealand Standard has three major categories According to Australian Radiation Protection and Nuclear Safety Agency (ARPANSA),

Table 1: UPF rating and protection category [13]

UPF Rating Protection	Category	% UV Radiation Blocked
15 - 24	Good	93.3 – 95.9
25 - 39	Very Good	96.0 – 97.4
40 and over	Excellent	97.5 or more

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Measurement of fabric density and weight: Fabric density means the ends per inch along the length and picks per inch along width measured according to ASTM D3775 - 17e1. Fabric GSM measured according to ASTM D3776M - 09a (2017).

III. Result and Discussion

The value of UPF increases with the increasing fabric density and weight for similar composition. To inspect the relationship between UPF, weight, composition, color and density, two approaches used here. One is investigating the change of UPF having same construction on different composition and another one is an identical composition having a different construction.

Table 2: Relationship of UPF with fabric density, composition, color and weight

Composition	GSM	EPI*PPI	Color	UPF
100% cotton	130	132*72	Black	28
			Red	13
60% cotton 40% polyester	130	132*72	Black	35
			Red	17
100% cotton	160	144*80	Black	32
			Red	15
60% cotton 40% polyester	160	144*80	Black	41
			Red	22

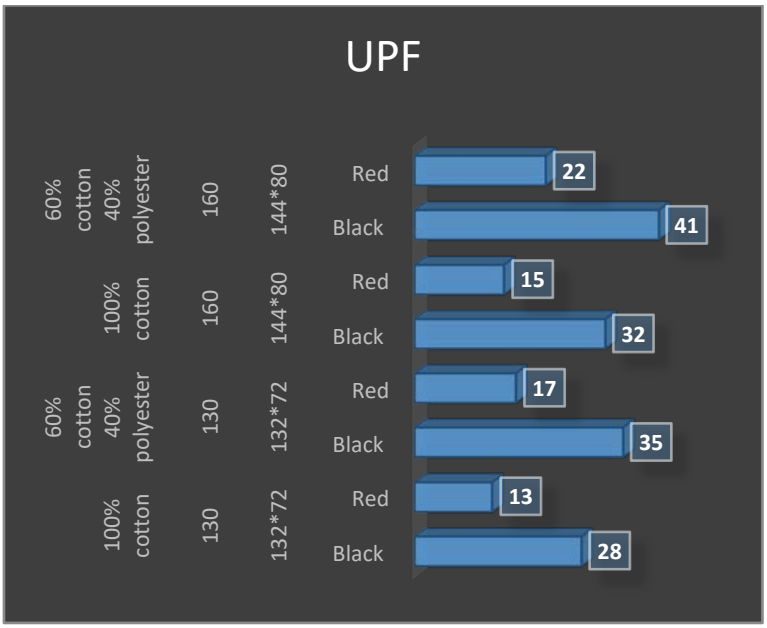

Figure 1: Relationship between color, weight and UPF rating.

As shown in figure 01, 100% cotton fabric has less UV protection power than the blended one. So polyester content in blended fabric enhances the UPF. Moreover, black color fabric has more UPF than red. Another finding of this study is the same color and identical composition fabric has different UPF because of different fabric density and weight. Higher the EPI and PPI values, higher the UPF value.

IV. Conclusion

This whole work is intended to establish a general idea on the issue of UV protection factor of a plain weave fabric simply. Considering fabric density, color and composition as main variables, UPF ratings are measured for different types of sample. UPF enhances with the increasing density, weight, the blended composition shows better value than the pure one, and black color shows excellent protection against UV. Though there are many other factors which can directly or indirectly influence the UV protection factor, here only a few represented. Also, establish a comparison among them. In addition, the most mentionable comparison is polyester has more UPF value than cotton.

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