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UV ray protection property and natural dye

MINTI GOGOI* AND ANUMONI GOGOI[1]
Department of Textiles and Apparel Designing, Faculty of Home Science,
Assam Agricultural University, Jorhat (Assam) India
[1]Duliajan Girls College, Dulianjan (Assam) India

ABSTRACT

The natural source of UV radiation is the sun with wavelengths shorter than that of visible region. It is known that UV-A radiation can generate highly reactive chemical intermediates which indirectly damage the DNA and in this way induces the skin cancer. UV-B damages the fundamental building element of DNA, directly at molecular level as well as collagen fibres and vitamin A in the skin. Recently numbers of studies proved that the UV blocking properties of a textile material can be enhanced by using natural dye along with natural mordant (colour intesifing groups). The H bond present in the molecules of natural dye has capacity to absorbed about 80% of the harmful UV ray that blocked UV light to passed through clothes to the skin.

Key Words : UV ray, Natural dye, DNA, Vitamin A

INTRODUCTION

There is increasing awareness among conscious consumers about their dress pattern in their day to day life. They are aware about environmental protection like to wear dresses which are eco-friendly, nontoxic and protect human health in all respects especially from the harmful UV ray of the sun. Human protection from Ultra violet (UV) ray of sun can be reduced by adopting different methods. Avoiding sun for 10 to 14 hours is a well known recommendation for protection of our body from UV ray. But the people who must work outdoors and limiting time for outdoor activity is not feasible, they need to protect their health through technically designed UV blocking clothing in conjunction with sunscreen to all exposed areas. Application of natural dyes particularly the dark colours from some of the plant extract can provide UV protection on the clothing(1).In United states special importance has been given on the effect of ultraviolet radiation on living biological organisms and various reporting methods such as UV index, UV protection factor (UPF) and solar protection factor (SPF) have been adopted to create awareness among the general public of the deleterious effects of UV radiations.

What is UV ray of sun ? :

The sun light is the inherent source of energy reaching the earth surface. Daylight

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reaches us from the sun through the earth's atmosphere ; its spectrum extends from 290 nm to 3000 nm. Radiation between 290 and 400 nm is referred to as Ultraviolet radiation. Approximately 5% of incidental sunlight constitute UV ray the energetically high, short wavelength of light. In fact,the ultraviolet radiation (UVR) band consists of three regions: UV-A (320 to 400 nm), UV-B (290 to320 nm), and UV-C (100 to 290 nm). UV-A causes little visible reaction on the skin but has been shown to decrease the immunological response of skin cells. UV-B is most responsible for the development of skin cancers. Luckly UV-C is totally absorbed by the atmosphere and does not reach the earth surface. All these three types UV radiation has wavelengths shorter than that of visible region, but longer than that of soft X-rays, in the range of 10 nm to 400 nm, and energies from 3 eV to 124 eV. Though the amount of UV radiation is quite less, it has the highest quantum energy compared to other radiation. The intensity and distribution of ultraviolet radiation depend closely on the angle of incidence; hence they vary with the location of the place, season and time of the day. Increasing duplication of ozone layer due to emissions from the surface there is steady increase in the amount of ultraviolet rays reaching on the earth surface. It is very much important to know that prolonged exposure to solar UV radiation may result in severe health problems particularly skin cancer, sunburn and photo-aging (Reinert *et al*., 1997).

The artificial sources of UV radiation are different types of lamps for phototherapy, solariums, industrial/work place lightening, industrial arc welding, hardening plastics, resins and inks, sterilizations, authentication of bank notes and documents, advertising, medical care, etc. UV lasers are also manufactured to emit light in the ultraviolet range for different applications in industry (laser engraving), medicine (dermatology, keratectomy) and computing (optical storage). Lamps and lasers emit UVA radiation, but some of them can be modified to produce UVB radiation.

Effect of UV rays on Human health:

There are big differences between the UVA, UVB and UVC (or UVD) radiation regarding their effects on human health.

UVA radiation is also known as glass transmission region (www.intechopen).while ordinary glass blocks over 90% of the radiation below 300 nm and passes the radiation about 350 nm. UVA radiation is thought to contribute to premature ageing and wrinkling of the skin while it damages collagen fibres and destroys vitamin A in the skin. It penetrates deeply under the skin but does not cause sunburn, only sun tanning which is a defense mechanism of the skin. Brown pigment melanin namely absorbs UVA radiation and dissipates the energy as harmless heat, blocking the UV from damaging skin tissue. Today it is also known that UVA radiation can generate highly reactive chemical intermediates which indirectly damage the DNA and in this way induces the skin cancer. UVA is the main cause of immune-suppression against a variety of infectious diseases (tuberculosis, leprosy, malaria, measles, chicken pot, herpes and fungal disease) rather than UVB, but the effects are also positive (type 1 diabetes, multiple sclerosis, rheumatoid arthritis). Ultraviolet rays (UV-A) cause a transformation of melanin precursors in the skin, leading to so-called rapid pigmentation, which sets in within a period of a few hours, but this is only a very minimal and of short duration. However, it penetrates deeply into the dermis or true skin, leading to premature

ageing, showing up in the form of loss of elasticity accompanied by lines and wrinkles.

UVB radiation is known as sunburn region and has been implicated as the major cause of skin cancers, sun burning and cataracts (Yalambie,2003). The shorter wavelength (290 nm-320 nm), but higher energy ultraviolet rays (UV-B) penetrate to a depth of a few mm into the skin, causing the formation of a relatively stable pigment in the cells of the outer layer of the skin. It damages the fundamental building element DNA directly at molecular level as well as collagen fibres and vitamin A in the skin.

How can we protect from UV ray ? :

The UV protection involves a combination of sun avoidance and the use of protective garments and accessories (Pailthorpe1995). Though protecting skin with clothing is a convenient and valid method common clothing made up of cotton, silk, wool and synthetic material are not effective for UV protection because UV ray can transport through them. As results special attention was focused by textile researchers on the fabric permeability to the UV radiation in the recent years (Eckhardt *et al.*, 2000; Srinivasan *et al.*, 2000). The UV radiation transmitted through a textile fabric consists of the waves that pass unchanged through the pores of the fabric and scattered waves that have interacted with the fabric. Crews *et al*., 1999 reported that manufacturers of sun protective clothing face a confusing array of information because the published literature contains many contradictory claims. Many research studies were conducted to establish the parameters that affect the UV permeability of the textile garment. Some studies concluded that the compactness and the weight of the fabric are the most relevant parameters, while others claim that dark colour shades offer more protection.

Recently, numbers of study proved that the *UV blocking properties of a textile can be enhanced by using natural dye along with natural mordant (colour intesifing groups*). The H bond present in the molecules of natural dye has capacity to absorbed about 80% of the harmful UV ray as it blocked UV light to passed through clothes to the skin. A study conducted by Shunghai University reported that textiles dyed with *Rheum and Lithospermum erythrorhizon* have excellent UV protection property. The fabric dyed with weld tree imparted the highest UV protection level. They also reported that dyeing of cotton fabrics with natural colorants from madder, cochineal and indigo increases the ultraviolet protective ability. Many plants such as henna, dyer's woad, logwood, Bheh, lipstick tree, madder, brazil wood, and cochineal as natural dyes could confer good UV protection. Natural dye indigo, annatto, gardenia, and cochineal could absorb about 80% of the ultraviolet rays. The application of those natural dyes can have a significant effect on UV protection provided by a fabric, depending on the concentration of dyes in the fabric and the absorbancy of dyes in the UV region, color, and chemical structure on the UV transmittance. It was also noted that naturally-coloured cottons contain pigment ranges from light green to tan, brown and inherent long-term UV protection properties (Edlich R.F) with a UPF of 64 and 47, whereas normal cotton shows a UPF of 8.

According to the study of Hustvedt and Crew (2005), fabrics from naturally pigmented cotton have excellent sun protection properties, which are far superior to conventional, bleached and unbleached cotton fabrics (green UPF=30-50+, tan UPF=20-45, brown UPF=40-

50+, bleached conventional UPF=4, unbleached conventional UPF=8). Their UV protection properties remain high enough even after 80 AFUs light exposure.

The dyes extracted from various natural resources showed the UPF within the range of 15 – 45 depending on the mordant used (Eckhardt and Rohwer, 2000.) Kansas State University reported that the naturally-pigmented cottons has excellent sun protection properties (high UPF values).The UPF is further enhanced with colorant of dark hues and with high concentration of the dye in the fabric. Undyed or bleached fabrics offer much lower protection against UV radiation if any in comparison with dyed fabrics. Natural dyes react like additives; they improve UV protection abilities, because they absorb UV radiation in the visible and UV radiation band, while in bleaching process the naturally occurring pigments and lignin that act as UV absorbers are removed and those affect UV absorber ability of cotton fabrics.

UV absorbers incorporated into the spinning dope prior to the fibre extrusion and dye bath. and in bath dyeing improve the light fastness of certain pastel shades and the weather ability of spun-dyed fibres. Initiatives for developing standards related to UV protection started in the 1990s, and standards related to the preparation of fabrics, testing and guidance for UV protection labeling have been formulated by different agencies (Rupp *et al*., 2001).The Skin Cancer Foundation, an international body, has offered a Seal of Recommendation for the photo-protective products which includes sunscreens, sunglasses, window films and laundry detergent additives .But the role of natural dye on UV protection is an recent innovation.

UPF Value:

Ultraviolet protection factor (UPF) is the scientific term used to indicate the amount of ultraviolet (UV) protection provided to skin by fabric. UPF is a rating system used for apparel. It indicates how effectively fabric shield skin from ultra violet rays. Higher the UPF number greater the degree UV protection a garment offer. UPF range 15-24 is good, 25-39 is very good and 40-50 is excellent .Any fabric that allow less than 2% UV transmission is simply labeled UPF 50+. Faded fabric is less effective against UV light. Repeated home laundering with common household detergent does not reduce the UPF rating of a woven and knitted fabrics of cotton, polyester and nylon. UPF value of material remain unchanged up to 20 times of repeated laundering.

SPF (Sun Protection Factor):

The solar protection factor (SPF) is defined as a quotient from a harmful dose without, and a harmful dose with, sun protection. This can be calculated from erythemal effectiveness (EW (λ)), (P(λ)) and from the wavelength dependent transmission of the sun protection agent. SPF values are analogous to UPF values the only distinction being that SPF values for sunscreens are determined through human testing whereas UPF values are based on instrumental measurements.

UV index :

The UV index is reported as the maximum biologically effective solar average UVR (UVReff) for the day, and is an average taken over either 10 or 30 minutes. The UVR is

usually highest around midday but the temperature is often highest later in the afternoon. UVR index values are grouped into five exposure categories, from low to extreme with different colour codes.

Conclusion:

The UV protection by textile materials and apparel is a function of the chemical characteristics, physico-chemical type of fibre, presence of UV absorbers, construction of fabric, thickness, porosity, moisture content ,extension of the fabric, colour and the finishing given to the fabric. The safest production from UV radiation exposer is possible with well-designed UVR blocking clothing and sunglasses equipped with lenses that filter UV ray visible light which arrived directly and indirectly through reflection. Eye protection can be increased by wearing a hat or visor which extend the natural anatomical projection of face. Darker colours dress of the same fabric type (black, navy, dark red) absorb UV ray much more strongly than the light pastel colours for identical weave. A report was published by WHO entitled as "Global burden of disease from solar ultraviolet radiation" showed a detailed estimates of UV-associated diseases. There is no other organic or natural economical means to protecting human life from the harmful effect of UV radiation except the use of natural dye on their dress. In order to minimise worldwide burden, and international call for protection of our body from the most harmful UVR it is an immediate need to think about the enhancement of UV protection property of our clothes by using eco-friendly, nontoxic and easily accessible natural dye.

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