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RESEARCH ARTICLE

Invasive weed *Lantana* utilization for textile finishes

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ABSTRACT

Herbal extract application on textile substrates is in great demand around the globe. In this study, a natural dye extracted from *Lantana camara* L. leaves' extract was tested to assess the ultra-violet protective properties on cotton fabric using direct dip dyeing technique. Extraction of phytochemicals was carried out using ethanol and aqueous solvents. Total phenolic content (TPC) quantification revealed that TPC of *L. camara* leaves' extracts were highest in ethanolic extraction as compared to aqueous extracts. The ultra violet protection factor (UVF) values ranged between good to excellent for the cotton fabrics. A cotton fabric treated in a solution containing cross linking agent showed a shade of light yellowish green. The colour fastness against light, washing, rubbing and perspiration of cotton fabric treated in extracted dye solution as well as treated with citric acid as cross-linking agent showed good to very good colour fastness properties (4–5). The results confirmed that natural dye from *Lantana camara* extract have potential for application in fabric dyeing and also helpful in producing UV protective fabric.

Keywords: *Lantana camara*, Dyeing, Fabric, UV protection, Weed utilization

INTRODUCTION

Clothing is a basic human need that traditionally is viewed as a means of satisfying the aesthetic needs of fashion, but today's need for fashion has been combined with a critical need for function. Human exposure to ultraviolet (UV) radiation has increased in recent years due to altered leisure habits and to higher overall level of UV radiations caused by the decreased ozone content of the atmosphere. UV radiations amounts to about 6 per cent of solar radiation and consists of UV-A (330-400 nm), UV-B (290-320 nm) and UV-C radiation (220-280 nm). Exposer to UV rays can cause not only sunburn but also premature skin aging. One of the most important elements in preventing skin cancer is the use of comfortable UV-protective clothing. Therefore, there is strong demand for means of providing UV protection and textiles play an important role as it is directly applied to the skin, when the UV radiation hits the textile materials, different types of interaction occur depending upon the substrate and its conditions. The UV protection by textiles materials and apparels is a function of the chemical characteristics, physico-chemical type of fibre, presence of UV absorber, fabric construction, thickness, porosity, extension of the fabric, moisture content of the fabric, colour and the finishing given to the fabric (Ashour and Ahmed 2016). Fabrics when dyed, can absorb significant amount of UV radiation and have a protective effect (Deepti *et al.* 2005). The degree of ultraviolet radiation protection of textile material is measured by the ultraviolet protection factor (UPF). The UPF is the measure of ultraviolet (UV) radiation blocked by the fabrics and indicates the amount of ultraviolet protection provided to skin by the fabric. Higher UPF value is indicative of more blocking of UV radiation.

Dyes often provide a good blocking effect against ultraviolet light transmittance and the protection level rises with an increase in dye concentration (Omer *et al.* 2015). The dyes used to colour textiles can have a considerable influence on their permeability to ultraviolet radiation. Any type of dye can provide the UV protection properties to the fabric but at present in the field of textiles, the application of natural dyes is on the rise because of the growing interest of the consumers towards the environmental sustainability. The fabric dyed with natural dyes have good ultraviolet protective properties and could absorb about 80 per cent of the ultra violet rays (Deepti *et al.* 2015). There are several plants which are available in abundance and have not yet been given any commercial importance; *Lantana camara* is one of them. Hence, keeping in mind it was decided to investigate the UV protection offered by *Lantana camara* dye on cotton fabric.

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Lantana is easy to grow anywhere in well-drained soil (Saravanan *et al.* 2014). The plant is an aromatic straggling shrub with prickly stem and strong unpleasant smell. It blooms all year long. It is considered as poisonous plant in nature but the leaves are used in traditional medicine. Chief constituents present in lantana are iridoid glycosides, flavonoids, sesquiterpenes, triterpenes, lantadene, lantanolic and lantic acid. Lantana is abundantly available in hilly and plain areas of Himachal Pradesh and throughout India.

Most of the plant materials used for the extraction of dyes are credited with medicinal properties. The tannins and other phenolic compounds present in plant kingdom are believed to provide a chemical defence against predators and ultraviolet radiation to the plant (Svobodova *et al.* 2003). A great attention for application of natural colourants is survived due to their availability. Moreover, natural dyeing practices can create employment avenues in rural area which can also help in promoting rural entrepreneurship. Some interested practitioners are using natural dyes for exclusive dyeing of handicrafts and handloom textiles at small scale in an attempt to produce green textiles (Babita and Anita 2018). Eventhough, synthetic colourants produce different shades and are available in low price, they cause environment pollution and hence, natural dyes are good alternative for textile colouration (Gawish *et al.* 2016). Plants have their own self defence mechanism and protect themselves from UV rays and microbes due to the presence of substances known as phytochemicals. These phytochemicals are divided into primary and secondary metabolite. Primary metabolites are the compounds involved in the metabolic pathway, which are common to all living organisms (Dewick 2009). Secondary metabolites extracted from plants such as phenols, flavonoids and anthrax-Quinone have been considered as sunscreen agents because of their ultraviolet absorption property (Ramu *et al.* 2012). Although, many plants rich in antibacterial and UV protective agents are reported, the work on the exploration of *Lantana camara* leaves extract and its application on textiles is not yet documented. Thus, the present study was planned to enhance the dyeing properties of cotton fabric using *Lantana camara* dye extract to impart functional properties into the dyed substrate as UV radiation protection.

MATERIALS AND METHODS

Fabric

Cotton fabric with plain weave, 120 GSM, 76 ends/inch and 60 pics/inch having 0.33 mm thickness was used for the study.

Scouring of fabric

In order to remove the impurities from the fabric, samples were treated in solution containing 2 g/litre of sodium hydroxide and 2 g/litre of detergent at material liquor ratio of 1:40 by raising the temperature of entire bath upto 40-60 ^{o}C and was maintained for one hour. After kneading and squeezing, fabric was rinsed in tap water and sundried (Sumithra and Raaja 2013).

Dye material collection

Lantana camara leaves selected as dye source were collected from Palampur region because of their availability in abundance and dried in shade until crispy. The dried leaves were pulverized and were sieved through a 0.5 mm size mesh to obtain uniform sample in the form of powder. The resulting powder was kept separately in glass container with screw cap and stored at room temperature prior to use (Maribet and Aurea 2008).

Dye extraction

Extract preparation from *Lantana camera* leaves was carried out in aqueous (100%) as well as ethanol (70%). In Aqueous extraction; 10 g of leaves were dissolved in 100 ml of distilled water and kept for overnight. After incubation for 24 hours, the extract was centrifuged and the amount of extract was measured. The final extract obtained was filtered using Whatman filter paper number 40 (125 mm), measured, stored in screw caped labelled sample bottles, refrigerated and used for further analysis. In ethanolic extraction 10 g leaves were macerated for 24 h in 70% v/v ethanol. After that vortex for 30 minutes and filtered through Whatman filter paper no. 40 (125 mm). The final extract obtained was filtered using Whatman filter paper no. 40 (125 mm), supernatant was measured, stored in screw caped labelled sample bottles, refrigerated and used for analysis. Further the aqueous as well as ethanol extract was used for the application on cotton fabric.

Before studying the UV protective properties of *L. camara* dyed cotton fabric, qualitative as well as quantitative screening of phyto-chemicals in leaves was carried out.

Qualitative phyto-chemical analysis

Qualitative phyto-chemical analysis of plant extracts was performed for the identification of various classes of active chemical constituents like alkaloids, flavonoids, phenolic compounds, tannins, saponins and terpenoids using different methods (Raman 2006).

Quantitative analysis - Total Phenolic Contents

Total phenolic content of the extract was determined by the Folin-Ciocalteu method and the result was expressed as mg of gallic acid equivalent per g dry weight (Kaur and Kapoor 2002).

Dyeing of cotton fabric

In case of control samples, scoured cotton fabric was immersed in previously prepared aqueous stock solution at 40°C and slowly the temperature was raised upto 90°C. Dyeing was carried out for one hour at neutral pH with adequate movement of dye liquor. The dye bath was allowed to cool for 15 minutes. The dyed samples were then removed, squeezed gently, washed thoroughly and shade dried (Anjali *et al.* 2013) whereas, in case of treated samples, after removing the samples from dye bath dyed samples were treated in stock solution containing 6% crosslinking agent *i.e.*, citric acid for one hour and after that cured the treated fabrics in oven for 30 sec. and then shade dried.

Ultra violet protection factor (UPF) of treated fabric samples was measured as per AATCC 183 test method.

Measurement of colour fastness properties

Colour fastness is the resistance of a material to change any of its colour characteristics or extent of transfer of its colorants to adjacent white materials in touch. The colour fastness is usually rated using greyscale either by loss of depth of colour in original sample or by staining adjacent white material. However, among all types of colour fastness, light fastness, wash fastness and rub fastness are considered most important for any textiles; perspiration fastness is more useful for apparels only (Samanta and Agarwal 2009). After dyeing samples were subjected to colour fastness test to light, washing, crocking or rubbing using the laboratory equipment like DIGI-Light, DIGI-Wash, crock-o-meter and perspire-o-meter, respectively as per the methods given in ISI Hand book of Textile Testing (1982). The fastness rating was given visually, according to Gray scale (AATCC Technical manual 1968) standards.

Physical properties of treated fabric

Thickness (mm), fabric count (no.), GSM, strength (Kgf) and per cent elongation were studied using standard method.

Thickness

Fabric thickness is the distance between the upper and lower surface of the fabric and was measured by a precision thickness gauge known as shirley's thickness tester by using ISI (IS:7702-1975) method. The fabric is kept on a flat anvil and a circular pressure foot is pressed on the fabric and is measured at several places keeping the fabric flat and under no tension. The width of the fabric is the average of the readings taken.

Fabric count

The fabric count of samples was determined by using digiTRA (Digital Traverse Thread Counter). Ten observations were made and average was calculated. The fabric count was expressed in ends/ inch and also picks/inch.

GSM

Gram per square meter (GSM) of dyes samples was measured using GSM cutters and then weighing the samples using digital weighing balance in the laboratory.

Strength (kgf) and % elongation

Tensile strength and per cent elongation of dyed samples was studied using tensile strength tester. Sample size of 25 cm × 5 cm was taken out in both warp and weft directions. The specimen was gripped centrally in between the clamps of tensile strength testing machine, with the longitudinal threads parallel to the direction of application of load. The required test parameters were applied to the instrument due to which continual increasing load was applied longitudinally to the specimen by moving one of the clamps until the specimen was ruptured. Finally, values of breaking strength were taken. A weight was used to ensure that the same amount of tension was put on each of the samples while securing the clamps. The peak load and breaking elongation of the fabric samples were measured. Average fabric tensile strength data was observed. Elongation- the average increase in length of the sample at its break (rupture) point.

RESULTS AND DISCUSSION

Extract yield from *Lantana camara* was measured as 21 ml per 50 ml in aqueous solution whereas it was 25 ml per 50 ml in solvent *i.e.* ethanol.

Not much variation in extract yield was observed. The presence of alkaloids, flavonoids, phenolic compounds and tannins, saponins and terpenoids was observed in *Lantana camera* leave's extract, extracted in aqueous as well as in ethanolic solvent (**Table 1**).

There are several types of solvents that can be used for extraction of plant extract such as methanol,

Table 1. Phyto-chemical analysis of *Lantana camera* Leaves

Phyto-chemical tests	Aqueous solution	Ethanol
Alkaloids		
Dragendorff's reagent	-	+
Wagner's reagent	+	-
Flavonoids		
Ammonia test	+	-
Sodium Hydroxide test	+	+
Phenolic compounds and tannins		
Ferric chloride reagent	+	+
Gelatin reagent	-	+
Lead acetate reagent	-	+
Saponins		
Foam test	+	-
Terpenoids		
Salkowski test	+	+

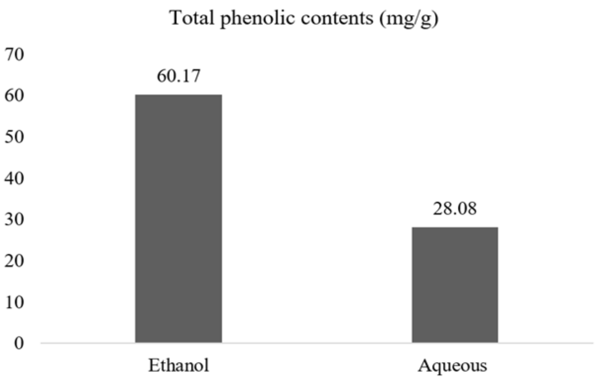

Figure 1. Total phenolic Content (TPC) in ethanol and aqueous extracts of lantana leaves

water, ethanol, acetone, *etc*. In present study ethanol and aqueous solvents were used for extract preparation in which maximum phenolic content was found in ethanolic extraction (60.17 mg/g), as compared to aqueous extraction (**Figure 1**).

The mean UVA per cent transmission of control (unfinished) cotton fabric was 7.70 whereas mean UVB per cent transmission was 8.57 and the mean UPF value was 10.9, providing no protection. Ultra violet protection factor (UPF) values varied from 11.0 (control-directly dyed) to 33.3 (treated) samples (**Table 2**). Per cent UV-A transmission and UV-B transmission was observed as higher (8.17 to 8.99) in control as compared to the treated samples (3.55 to 3.07). Not much variation in percent blocking UV-A and UV-B was observed in both control as well as treated samples. UPF rating of *L. camara* dyed control as well as treated samples varied from moderate to very good.

Beautiful tints and shades of green were obtained on the samples after dyeing with *L. camara* leaves whereas good to very good colour fastness properties were also observed in directly dip dyed control as well as citric acid as cross-linking treated cotton fabric samples. Grey scale rating for all the dyed samples were observed between 3 (moderate) to 5 (very good) (**Table 3**). During testing more colour staining was observed in cotton samples as compared to the woollen samples.

Fabric application of selected herbal finish was carried out using direct dip method. Performance of fabric treated with selected herbal finishing was observed using standard methods. Slight increase in thickness, fabric count, GSM, strength and elongation was observed when compared with white cotton fabric and which varied from 0.35 mm, 98 ends / inch / and 70 picks / inch, 1.205, 13.6 Kgf and 13.0% in control samples where samples were dyed directly in *L. camara* dye extract to 0.37 mm, 94 ends / inch and 70 picks / inch, 1.266, 15.70 Kgf and 17.0 per cent in treated samples (**Table 4**), where citric acid was used as cross-linking agent.

Conclusion

This study revealed that the colour obtained from *L. camara* leaves dye ranged from light yellowish green to dark green and *L. camara* leaves can be successfully used because of having good UV

Table 2. Evaluation of UV Protective properties of *Lantana camara* dyed samples

Dyed samples	UPF	Transmission (UV-A) %	Transmission (UV-B) %	Blocking (UV-A) %	Blocking (UV-B) %
Control (directly dyed)	11.0	8.17	8.99	91.83	91.01
Treated – (citric acid)	33.3	3.55	3.07	96.45	96.93

Table 3. Colour fastness of samples dyed using natural sources used for functional finishes

Plant source		Colour fastness grades												
		Washing			Rubbing				Perspiration					
			Colour stain		Dry		Wet		Acidic			Alkaline		
	light	Colour change	Wool	Cotton	Colour change	CW	Colour change	Cotton	Colour change	CW Wool	CW Cotton	Colour change	CW Wool	CW Cotton
Lantana camara														
Control (directly dyed)	3	4	5	4/5	4	4/5	3/4	4	4	4/5	4	4	5	4
Treated – (citric acid)	4	4	5	4/5	3/4	4	3	4	4/5	4/5	4/5	4/5	5	4/5

Table 4. Physical properties of fabric treated with herbal finish

Name of the plant source	Parameters				
	Direct dip method				
Lantana camara	Thickness (mm)	Count (no.)	GSM	Strength (Kgf)	Elongation (%)
Control (directly dyed)	0.35	98 ends / inch 70 picks / inch	1.205	13.6	13.0
Treated – (citric acid)	0.37	94 ends / inch 70 picks / inch	1.266	15.7	17.0

protective as well as colour fastness properties. As *Lantana camara* whole plant has great potential due to its protective properties, further studies are needed for practical utilisation of the findings of this study.

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