Dyeing cotton with *Camellia* 'Night Rider'

M. Bonet-Aracil[1], E. Bou-Belda[1], J. Gisbert Paya[1], and B. Piñeiro-Lago[2]
[1] Textile and Paper Department, Universitat Politècnica de València. Plaza Ferrándiz y Carbonell s/n, 03801 Alcoy, Spain
[2] Dept. Innovation, Pazo Quinteiro da Cruz. A Cruz 12–Lois, 36635 Ribadumia, Pontevedra, Spain
E-mail of contact persona: maboar@txp.upv.es, info@pazoquinteirodacruz.es

Abstract

Some research demonstrates that the different parts of a plant can be useful to obtain active ingredients. For example, some medical plants offer drugs from barks, leaves, seeds, or any other parts of the plant. Some recent studies have demonstrated that when camellia extractions are applied to dye cotton fabrics, not only colour but new properties such as ultraviolet protection are conferred to the fabric.

In this study different parts of leaves and flowers from the *Camellia* 'Night Rider' were studied. The colour was characterized by colorimetric coordinates and the Ultraviolet Protection Factor (UPF) was measured.
Keywords: Natural dye, cotton, ultraviolet, protection

1. INTRODUCTION

Natural dyes have been widely used since ancient times, in artisanal painting. Nowadays the use of natural dyes in the textile industry is scarce. However, there are groups of people, who due to their culture and customs, follow this practice of using natural dyeing resources which impart their own nature. Even this custom is gradually being lost, perhaps due to artificial dyes, which have better dyeing properties, standardized dyeing processes, uniform colors, dye durability, and so on.

Because of environmental issues, some concern about the use of non-pollutant and biodegradable materials is increasing. Among the industries worried about sustainability we can find the textile one. During the value chain of a garment, we can find there are many processes – particularly dyeing and finishing – which are among those that can be considered as the most polluting among industry. Thus, natural dyes are being considered again as an alternative to the synthetic ones and this industry is emerging again.

Natural dyes can be obtained from vegetables, animals or even microorganisms. It is widely believed that natural dyes are capable of dyeing some textiles but only with colours used on cloths in the Middle Ages. But this is a common misconception: natural dyes can produce an enormous variety of colours far away from only beiges and browns and other washed-out shades. In reality, vibrant, fast natural colours can be produced, which are comparable with and often surpass the colours of synthetics. The dyes have been improving

over time, more and more techniques are being improved, and standardized procedures are developed to be uniform in color and durable over time.

Some plant sources have been explored for natural dyeing. Camellia is among them and they are considered not only for their interest in the colour the textile can impart but also because of the properties they can confer.

In this study we tried to determine the different parts of the plant able to impart protection against ultraviolet light when cotton fabrics are dyed. Salt is used to increase the color migration towards the fabric without problems. The evaluation was conducted by two procedures -- dyeing with salt and without salt -- in order to establish if it is really necessary to add this component to the recipe.

2. EXPERIMENTAL

Materials

The fabrics used were 100% cotton twill of 210 g/m^2 weight and 100% cotton plain fabric of 150 g/m^2 weight. The natural dyes used were obtained from *Camelia* 'Night Rider' samples. The samples we tested were dried leaves, old leaves, flowers, and fresh leaves.

Methods

1.1. Extraction

The dyeing bath was obtained by infusion of *Camellia* 'Night Rider'. The selected parts of the plant were boiled in distilled water for 20 minutes and the liquor obtained was used for the dyeing process.

1.2. Dyeing

Dyeing was performed using a M: L (material to liquor) ratio of 1:40, at 100 °C for 45 minutes. Finally, the fabric samples were washed thoroughly with cold water, squeezed and dried.

Dyeing was carried out in following variations:

- 200 mL dyeing bath (40 mL tea extract/ 160 mL distilled water); 5 g fabric sample
- 200 mL dyeing bath (40 mL tea extract/ 160 mL distilled water); 5 g fabric sample; 0,4 g Na_2SO_4 (2 g/L)

1.3. Colour measurement

Colour values were evaluated in terms of CIELab values (L, a, b, c, h) and reflectance using standard illuminant D65 and 10° observed with specular radiation excluded on a Minolta CM-3600d visible spectrophotometer and provided with the Spectramagic software.

A total colour difference of dyed samples was obtained using the following relationship:

$$\Delta E = \sqrt{(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2}$$

Where ΔL * = L * with microcapsules; L * without microcapsules; Δa * = a * with microcapsules - a * without microcapsules; Δb * = b * with microcapsules - b * without microcapsules; "L *" describes the luminosity, "a *" measure of red-green hues, "b *" measure of blue-yellow shades. It should be noted that three measurements were made for each sample and the mean value was calculated.

1.4. UV protection

The method used to evaluate the ultraviolet protection factor was composed of an UV-lamp, a digital detector of UV radiation and opaque box. A UV radiation lamp VL-6.C, a photodetector Delta Ohm HD 2102.2 were connected to the computer. The entire system was in an opaque box to avoid light interferences.

The UVA-lamp irradiated at 312 nm and the UVB-lamp at 365 nm. The UPF can be calculated by the equation:

$$UPF = \frac{E(312) \cdot \varepsilon(312) \cdot \Delta(\lambda) + e(365) \cdot \varepsilon(365) \cdot \Delta(\lambda)}{E(312) \cdot \varepsilon(312) \cdot T(312) \cdot \Delta(\lambda) + E(365) \cdot \varepsilon(365) \cdot T(365) \cdot \Delta(\lambda)}$$

3.- RESULTS

A spectrophotometer was used In order to observe the colour from the fabric objectively. This measurement offers a value related to the reddish colour or greenish for a* parameter or from blueish to yellowish related to b* parameter. Table 1 offers the resultant values from the measurement.

From table 1, it can be seen that every treatment with *Camellia '*Night Rider' extraction offers some colour. ΔE values show that the colour intensity can be easily appreciated, consequently at first sight we can conclude that *Camellia '*Night Rider' is capable of dyeing cotton fibres.

It is easy to conclude that samples dyed with salt are not coloured as intensely as samples dyed without salt. Thus we can state that for dyeing with *Camelia '*Night Rider', it is convenient to avoid salt as it is not increasing the dyeing yield. The salt would also increase the wastewater conductivity and consequently it would be more polluting than the system without salt.

Table 1. CIELab values of cotton dyed

	L*	a*	b*	ΔL*	Δa*	Δb*	ΔE
bleached cotton	88,50	-0,49	3,07				

Camellia Night Rider	old leaves	without salt	74,63	2,62	9,22	-13,87	3,11	6,15	15,49
		with salt	81,31	0,18	12,06	-7,19	0,67	8,99	11,53
	dried leaves	without salt	70,28	4,10	12,49	-18,22	4,59	9,41	21,01
		with salt	75,88	3,64	12,38	-12,62	4,13	9,31	16,22
	flowers	without salt	82,55	0,38	12,43	-5,95	0,87	9,36	11,13
		with salt	79,71	2,06	6,95	-8,79	2,55	3,88	9,94
	fresh leaves	without salt	75,39	2,97	15,25	-13,11	3,46	12,18	18,23
		with salt	75,14	3,03	14,02	-13,35	3,52	10,95	17,62

Apparently, it seems that leaves are the part of the plant with higher values of colour, whereas flowers offer only a shadow on the fabric. Colour from the fabrics dyed with fresh leaves is higher in values than the one from samples with dried leaves.

On the other hand, when the fabric is characterised by other properties, ultraviolet protection factor value can be calculated. Table 2 shows results from the different fabrics. A direct relationship can be stablished between the dried leaves (the highest) and the fresh leaves or the old leaves (the lowest). However, the flowers show an even lower value in comparison with the lowest old leaves.

Table 2. UPF values of samples dyed with extraction.

		UPF	
		dyeing without salt	dyeing with salt
undyed cotton with chitosan		1,36	
Camellia Night Rider	dried leaves	46,16	37,6
	flowers	7	7,12
	fresh leaves	39	34,33
	old leaves	15,5	9,05

If we compare results from colour intensity against UPF values, it has been demonstrated that colour intensity is not directly related to the UPF values. Further studies would be made according to the chemical composition of the different parts in order to stablish which are the chemical compounds which influence the ultraviolet protection.

4.- CONCLUSIONS

In this paper we studied the behaviour of *Camellia* 'Night Rider' when dyeing cotton using the extracts from different parts of the plant. We could observe that *Camellia* 'Night Rider' Is capable of dyeing cotton fibres and that there is a different behaviour depending on the part of the plant. Moreover, if the leaves are treated differently, we can observe a

considerable influence on the colour the fabric shows.

Furthermore, when fabrics are evaluated against UPF we can observe there is not a direct relationship between colour intensity and UPF protection what allows to think that the leaves treatment influences the active ingredients to confer ultraviolet protection.

REFERENCES

Bechtold, T.; Mahmud-Ali, A.; Mussak, R. Natural dyes for textile dyeing: A comparison of methods to assess the quality of Canadian golden rod plant material., *Dyes and Pigments ,* vol. 75, pp. 287-293, 2007

Bonet-Aracil,M.; Díaz-García, P.; Bou-Belda, E.; Sebastia, N.; Montoro, A.; Rodrigo, R. UV Protection from Cotton Fabrics Dyed with Different Tea Extracts.
Dyes and Pigments (2016).134. 448-452

Bonet-Aracil, M; Bou-Belda, E; Díaz-García,P.; B. Piñeiro-Lago. Evaluation of Tea Process on the Ultraviolet Proteciton Properties. 2018. Proceedings of the International Camellia Society Congress. Pp. 286-291

SUFFNESS, Matthew; DOUROS, John. Current status of the NCI plant and animal product program. *Journal of Natural Products*, 1982, vol. 45, no 1, p. 1-14.

VANKAR, P. S. Newer natural dyes for cotton. Natural Dyes for Textiles: Sources, Chemistry and Applications, 2017, p. 1-15