ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

DYEING COTTON WITH EISENIA BICYCLIS AS NATURAL DYE USING DIFFERENT BIOMORDANTS

BONET Mª Ángeles[1], BOU Eva[1], MONTAVA Ignacio[1], DIAZ Pablo[1]

[1] Universitat Politècnica de València, Textile and Paper Department, Plaza Ferrándiz y Carbonell s/n, 03801, Alcoy, Spain.

Corresponding author: Bonet, M. E-mail: maboar@txp.upv.es

Abstract: *Natural dyes are known for their use in colouring of food substrate, leather as well as natural protein fibres like wool, silk and cotton as major areas of application since pre-historic times. Nowadays, there has been revival of the growing interest on the application of natural dyes on natural fibres due to worldwide environmental consciousness. Some researchers focus their studies on the improvement of these dyes using mordants. Most works use metallic mordants like aluminum or iron are used, but some of them are hazardous. In this work we used a biomordant to solve environmental problems caused by metallic mordants. The effects of chitosan weight molecular in mordanting on the dyeing characteristics and the UV protection property were examined in this study. Chitosan mordanted Eisenia Bicyclis dyed cotton showed better dyeing characteristic and higher UV protection property compared with undyed cotton fabric. To analize the differences of the dyeing, reflection spectrophotometer was used, evaluating the results of CIELAB colour diference values and the strength colour (in terms of K/S value). We conclude that the type of chitosan used affect the dyeing efficiency and the UV protection, showing different behaviour between dye sample using chitosan with low or medium molecular weight.*

Key words: *Chitosan, natural dye, seaweed, UV protection, mordant.*

1. INTRODUCTION

Recently there has been increasing interest in the use of natural dyes in textile industry. This is a result of the enviromental standards imposed by many countries in a response of the toxic and allergic reactions associated with some synthetic dyes [1]. Several works have studied the properties of the natural colourants, which show more biodegradability and higher compatibility with the enviromen [2]. However, it is well known that the problems in dyeing with natural colorants are the low exhaustion colours and the poor fastness properties of dyed fabrics [3]. These problems have been solved using metallic salts as a modants to improve fastness properties ans to develop different shades with the same dye [4-6], but this type of compounds are more complex and it will take a long time for them to complete their natural cycles and return to nature, for this reason they cause a lot of environmental pollution.

Several biomordents have been studied by researches, such as chitosan. This is a deacetylated derivative of chitin, a natural polymer found in the shell of crabs and shrimps. Structurally, chitosan contains two main functional groups, namely hydroxyl and amino groups, as well as ether linkages. It has also been used to treat cotton in dyeing processes [7]. It was found that chitosan increase dye sorption on cotton.

The present study focuses on dyeng of cotton fibres, with the *Eisenia Bicyclis (*seaweed) extract using chitosan as a mordant, using two types of chitosan with diffierent molecular weight (low and medium). The purpose is also investigate the dyeing behaviour and fasteness properties. The comparasons between two different dyed samples were made, the depths of shade were evaluated by K/S value and CIELAB colour differences values of the dyed cotton fabrics and we analized the UV protection of each sample.

2. EXPERIMENTAL

2.1 Materials

The fabric used was a 100% cotton twill fabric with 210 g/m2, which had been chemically bleached in an industrial process. Both type of chitosan, medium and low molecular weight were purchased from the Aldrich Chemical Company and seaweed Eisenia Bicyclis … This seaweed is limited in distribution to temperate Pacific ocean waters, mostly around Japan, although it is deliberately cultured elsewhere, including South Korea and is a species of kelp best known for its use in Japanese cuisine.

2.2 Extract preparation

Aqueous extract was prepared by adding 2 g of Eisenia Bicylis to 200 ml distilled water. The mixture was heated at 100ºC for 1 hour, allowed to stand for 30 min and then filtered. The filtrate was used for dyeing.

2.3 Cotton pretreatment with chitosan and dyeing

A 5 g/L solution of chitosan was prepared, 3 g/L of acetic acid was need to dissolve the amount of chitosan. Were prepared two solutions using different chitosan in each one. Cotton fabrics were treatted by padding (80-85% pick-up). After this time the teatred fabrics were dried at 80 °C and then cured at 120 °C for 3 min.

Dyeing experiments were performed using M:L (material to liquor) ratio of 1:40 with manual agitation using 50% dye concentration. Dye baths temperatures were raised to 90-95ºC for 1 h.

2.4 Methods

Dyed samples were prepared for colour measurement, which was carried out by following a standard procedure. Colour values were evaluated by means of K/S and CIELAB colour-difference values (illuminant D65/10° observer) on Minolta CM-3600d UV-visible spectrophotometer.

The relative colour strength (in terms of K/S value) of different natural dyed cotton fabrics was measured by the light reflectance technique using the Kubelka–Munk equation [8-11].

$$K/S = (1 - R)2/2R \quad \textbf{(1)}$$

where K is the coefficient of absorption; S is the coefficient of scattering and R is the reflectance.

The method to evaluate the ultraviolet protection factor was composed of an UV lamp, a digital detector of UV radiation and an opaque box [12]. The UV-lamp irradiates at 312 and 365 nm, which belongs to UVB and UVA radiation severally. The detector of ultraviolet rays is found perpendicular to the UV-lamp and the fabric is above it. The system is into an opaque box to avoid lighting interferences.

3. RESULTS

The colour values (L,a,b) and the colour difference values (DE*ab) of the undyed and dyed samples with different chitosan are given in table 1. L* represents lightness value, the higher the lightness value represent lower the colour yield. a* and b* Represent the tone of the colour, positive values of a* and b* represent redder and yellower tones while negative shows greener and bluer tones. As can be noticed, the lightness of the dyeing decreases in both cases while the a and b values are increases respect undyed sample. On the other hand, sample dyed with Eisenia Bicylis extract by using médium chitosan as a mordant show greater difference color.

Table 1: *Colour values and CIELAB colour difference values of each sample.*

	D65/10°			
	L*	**a***	**b***	**DE*ab**
Undyed sample	**95,2415**	**-0,1429**	**3,7158**	**-**
Low chitosan	76,5228	5,4044	12,4749	**21,40**
Medium chitosan	72,06	6,9572	13,2545	**26,05**

Figure 1 shows the value of strength colour K/S and it is clear that the medium chitosan used as mordant have a considerable effect on the dyeability of cotton fabrics with Eisenia Bicylis dye under the same conditions, using the chitosan with higher molecular weight the strength colour is greater.

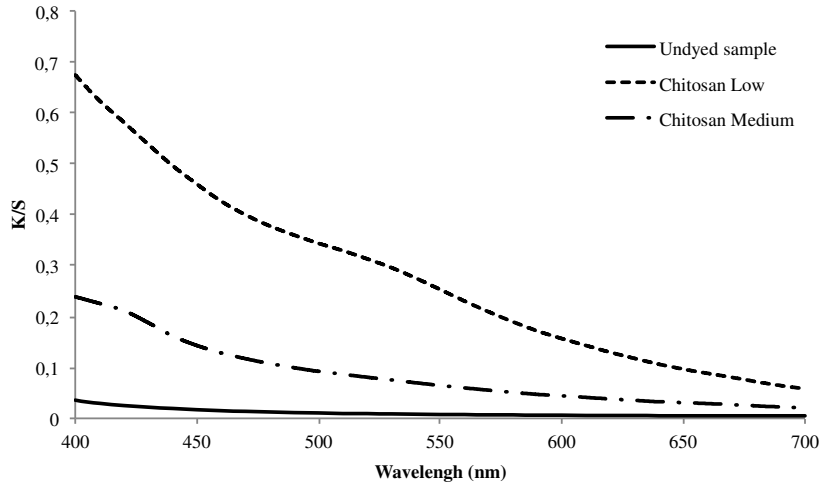

Fig. 1: *The colour strength (K/S) of undyed and dyed cotton fabrics using different types of chitosan*

The results of the UV protection (UPV) for each sample are shown in figure 2, it can observed that both treaments made in this study caused an improvement in UV protection of the cotton fabric.

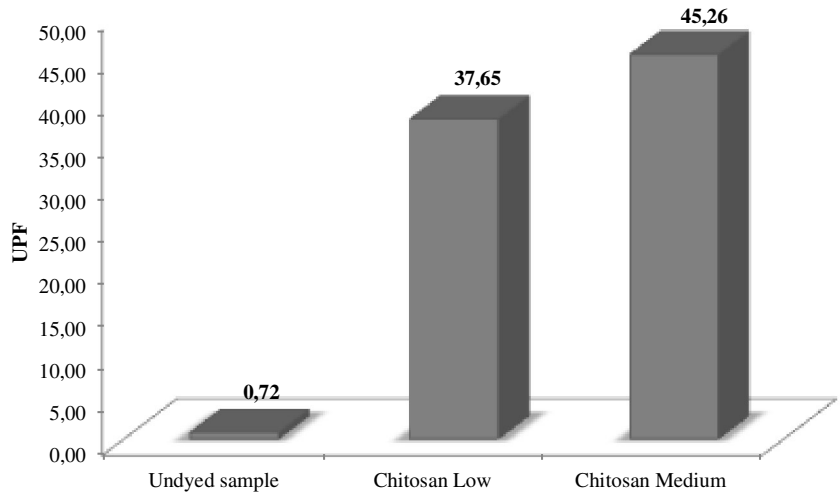

Fig. 2 : *UPF values of each sample*

Cotton fabric dyed with Eisenia Bicylis and chitosan as a mordant offering very good protection (UPF values between 25 and 39). However, there is a significant difference between the chitosan used, as cotton pre-treated with medium chitosan could be classified as excellent UV protection (UPF values equal or greater than 40).

4. CONCLUSIONS

In this study, it was observed that cotton fabrics dyed with a Eisenia Bicylis extract using two chitosan with different molecular weight (medium and low) showed that premordanting with this type of biomordant results an improvement of uniformity and color stregth of dyed cotton fabric. The pretreatment with medium chitosan produces higher K/S value and color differences respect undyed

sample.

Bleached cotton fabric have no UV protection properties, whereas when this fabric is pretreated with chitosan and then, dyed with Eisenia Bicylis, we get very good UV protection, being excellent UV protection when chitosan medium is used.

REFERENCES

[1]. Deo, H. T., Desai, B. K. (1999). Dyeing of cotton and jute with tea as a natural dye. *Coloration Technology*, 115,7-8, 224-227.

[2]. Mirjalili, M., Nazarpoor, K., & Karimi, L. (2011). Eco-friendly dyeing of wool using natural dye from weld as co-partner with synthetic dye. *Journal of Cleaner Produc*tion, 19, 9, 1045-1051.

[3]. Lee, Y. H. (2007). Dyeing, fastness, and deodorizing properties of cotton, silk, and wool fabrics dyed with coffee sludge (Coffea arabica L.) extract. Journal of applied polymer science, 103, 1, 251-257.

[4]. Rajendran, R., Balakumar, C., Kalaivani, J., Sivakumar, R. (2011). Dual Functionalization of Cotton Fabrics Using Punica Granatum with Antimicrobial and Dyeability Properties. *Journal of Textile and Apparel*, Technology and Management, 7, 2.

[5]. Jung, Y. S., Bae, D. G. (2014). Natural dyeing with black cowpea seed coat. I. Dyeing properties of cotton and silk fabrics. *Fibers and Polymers*, 15, 1, 138-144.

[6]. Samantaa, A. K., Agarwal, P. (2009). Application of natural dyes on textiles. *Indian Journal of Fibre & Textile Research*, 34, 384-399.

[7]. Rattanaphani, S., Chairat, M., Bremner, J. B., Rattanaphani, V. (2007). An adsorption and thermodynamic study of lac dyeing on cotton pretreated with chitosan. *Dyes and pigments*, 72, 1, 88-96.

[8]. Vankar, P. S., Shanker, R., Mahanta, D., & Tiwari, S. C. (2008). Ecofriendly sonicator dyeing of cotton with Rubia cordifolia Linn. using biomordant. *Dyes and pigments*, 76, 1, 207-212.

[9]. Vankar, P. S., Shanker, R., & Verma, A. (2007). Enzymatic natural dyeing of cotton and silk fabrics without metal mordants. *Journal of Cleaner Production*, 15, 15, 1441-1450.

[10]. Ahmed, N. S. (2005). The use of sodium edate in the dyeing of cotton with reactive dyes. Dyes and Pigments, 65, 3, 221-225.

[11]. Chattopadhyay, S. N., Pan, N. C., Roy, A. K., Khan, A. (2015). Sustainable Coloration of Jute Fabric using Natural Dyes with Improved Color Yield and Functional Properties. *AATCC Journal of Research*, 2, 2, 28-36.

[12]. Campos, J., Diaz, P., Montava, I., Bonet, M., Bou-Belda, E. (2013) Ultraviolet Protection of seaweed threads in textiles. *International Conference Innovate solutions for sustainable development of textiles and leather industry*, 35-39.