# Dyeing Properties of Natural Dyes Extracted from Eucalyptus

[1]N. NISAR, [1]S. ALI, [2]T. HUSSAIN*
[1]*Department of Chemistry, University of Agriculture, Faisalabad, Pakistan.*
[2]*Department of Textile Chemistry, National Textile University, Faisalabad, Pakistan.*

(Received 27th May 2006, revised 15th November 2006)

**Summary:** A natural dye was extracted from *Eucalyptus camaldulensis* and was used to dye cotton, by application of the direct dyeing method at different dyeing conditions. Then, the fastness properties of dyeings which different dyeing, techniques were compared. The dye was found to have good saturation and moderate fastness properties on cotton.

## Introduction

Natural dyes comprise colorants that are obtained from animals or vegetables matter without any chemical processing [1]. Increasing awareness of the environmental and health hazards associated with the synthesis, processing and use of synthetic dyes, has created a worldwide interest in textiles, dyed with natural dyes. During the last decade, the use of natural dyes has gained momentum due to increased demand for these dyes in the food, pharmaceutical, cosmetic as well as the textile coloration industry.

Textile processing industry is one of the major environmental polluters. In order to process a ton of textile, one might have to use as much as 230 to 270 tons of water. The effluent generated by this much water would pollute the environment as it may contain a heavy load of chemicals used during textile processing. There are two main ways to limit the environmental impact of textile processing. One is to construct sufficiently large and highly effective effluent treatment plants, and the other way is to make use of dyes and chemicals that are environment-friendly.

Natural dyes are eco-friendly, bio-degradable, less toxic and less allergic as compared to synthetic dyes [2]. However, in spite of several advantages of natural dyes over the synthetics, the use of the former is still very limited due to non-availability of standard shade cards and standard application procedures. Most natural dyes have no substantivity for the fiber and are required to be used in conjunction with mordants. A mordant, usually a metallic salt, is regarded as a chemical, which can itself be fixed on the fiber as well as combines with the dyestuff. A link is formed between the fiber and the dye, which allows certain dyes with no or little affinity for the fiber to be fixed [3].

Various national and international institutes have been engaged in extracting colors from natural sources and efforts are still being made by researchers to overcome various drawbacks of natural dyes such as poor reproducibility and lack of desirable fastness properties [4]. This work is concerned with the extraction of dye from Eucalyptus and its application on cotton fiber in an endeavor to investigate optimal extraction and application conditions to attain desirable fastness properties.

Eucalyptus grows on swampland, valleys and mountains. Its trees are characterized by their leathery whitish leaves with a peculiar aroma. Eucalyptus bark is one of the most important sources of yellowish brown colorant. The coloring matter of Eucalyptus has ample natural tannins and polyphenols, varying from 10-12 %. The important com-pounds found in the Eucalyptus bark are eriodictyol, naringenin, quercetin, rhamnazin, rhamnetin and toxifolin, apart from tannins of which some are colorants. The major coloring component of Eucalyptus bark is quercetin, which is also an anti-oxidant.

## Results and Discussion

### *Effect of Extraction Conditions*

The relative color strength of the dye extracts, obtained under different extraction conditions, is given in Figure 1.

As can be seen from the Figure 1, color strength of dye extracts, obtained at room temperature was minimum, slightly getting better at 60 °C and maximum when the extractions were carried out at boiling temperature.

*To whom all correspondence should be addressed.

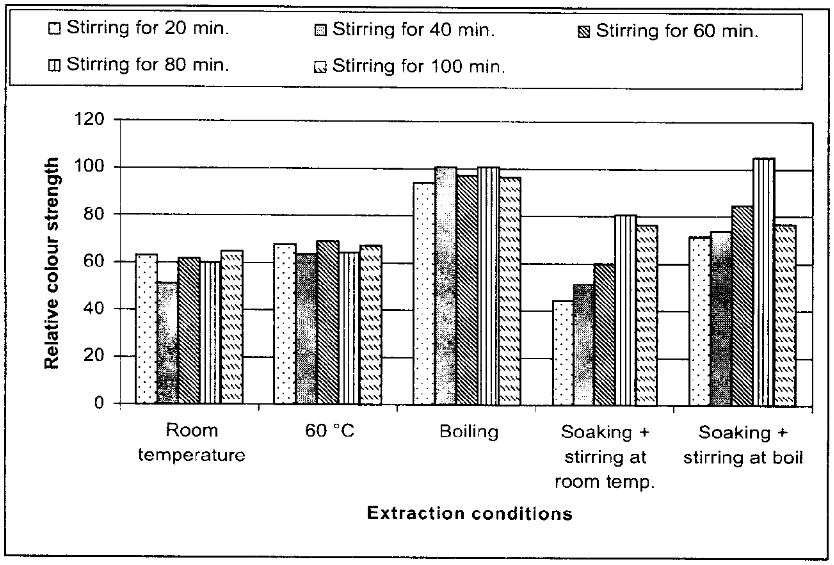


Fig. 1: Relative colour strength obtained under different extraction conditions

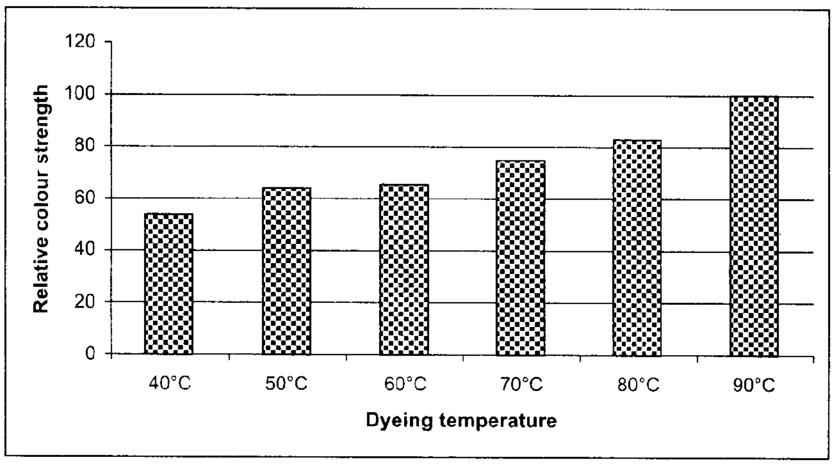


Fig. 2: Effect of dyeing temperature on colour strength.

For extractions at room temperature, 60 °C and boil, the effect of stirring was sporadic. However, for extractions after overnight pre-soaking, the color strength of dye extracts increased by increasing the stirring time up to 80 minutes. The color strength decreased from the maximum value when stirring was done for more than 80 minutes. This happened because after such a long stirring time, some impurities were also extracted along with the coloring components, thus decreasing the overall color strength of the dye extract.

In case of soaking and stirring for more than 80 minutes at room temperature, the color strength of the dye extract was more than that obtained without soaking. When the soaked material was heated to boil, color strength was increased but it was less than that obtained without pre-soaking. It was due to the softening of the cell wall because of soaking, which resulted in the release of impurities along with the coloring components during extraction.

*Effect of Dyeing Conditions*

The effect of dyeing temperature on color strength is demonstrated in Figure 2. Maximum color strength was obtained at 90 °C.

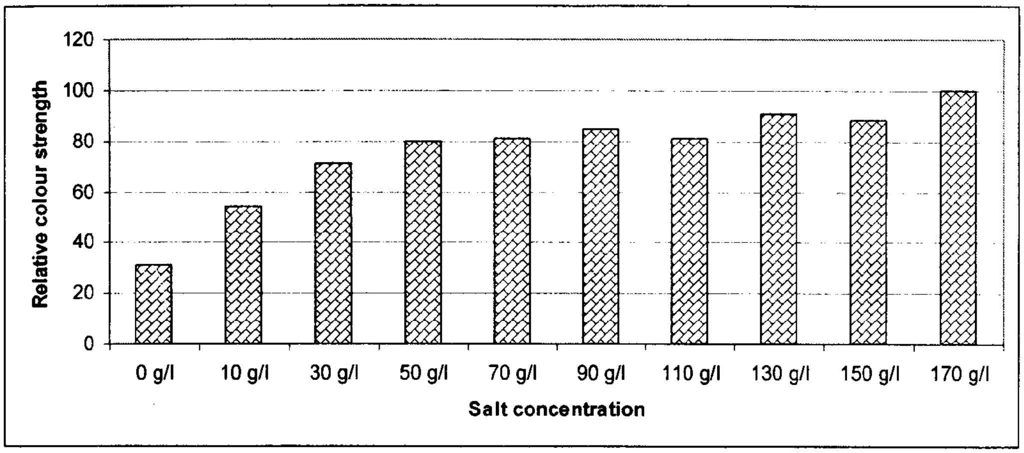


Fig. 3: Effect of salt concentration on colour strength

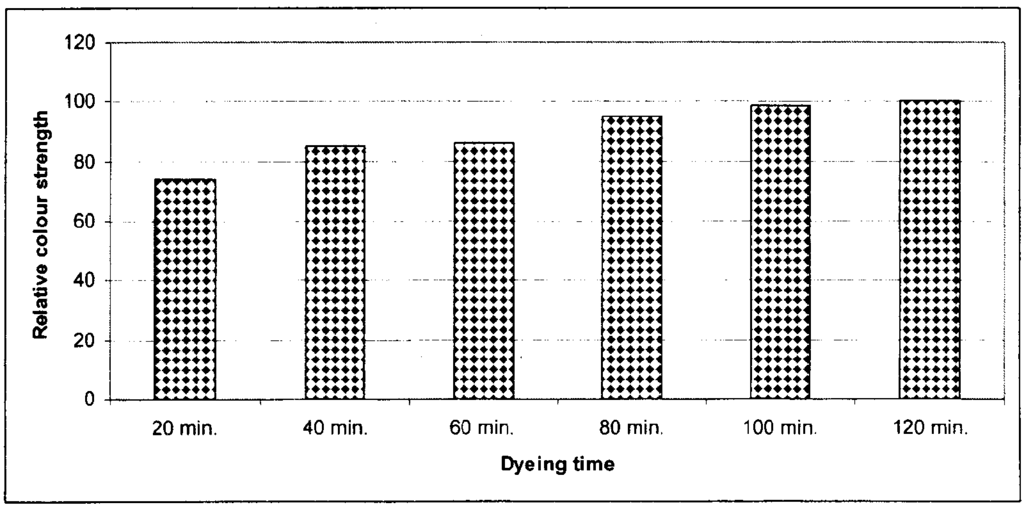


Fig. 4: Effect of dyeing time on colour strength.

Effect of salt concentration on color strength is shown in Figure 3. The color strength was increased steadily by increasing salt concentration from 0 to 90 g/ l. A further increase in salt concentration had a sporadic effect because of increased dye aggregation at high salt concentrations.

Effect of dyeing time on color strength is shown in Figure 4. The longer the dyeing time, the higher is the color strength until dye exhaustion attains equilibrium and there is no significant increase in the color strength after further increase in dyeing time.

The color coordinates of the sample dyed at the optimized conditions are given in Figure 5. As

| L* | a* | b* | C* | h |
|---|---|---|---|---|
| 47.18 | 17.38 | 24.93 | 30.39 | 55.11 |

Fig. 5: Color coordinates of the cotton dyed under optimized conditions

can be noticed from these values, the shade obtained by the dye extracted from Eucalyptus is yellowish brown with fairly good chroma, indicated by L* C* and h. The tone of the dye is reddish and yellowish, as is indicated by the +ve values of a* and b*, respectively.

*Fastness Properties*

Figure 6 shows the fastness properties of the cotton sample dyed under optimized conditions. As can be seen, the dye has fairly good fastness

| Washing fastness (staining on cotton) | Dry rubbing | Wet rubbing | Light fastness |
|---|---|---|---|
| 4 | 4-5 | 3 | 5 |

Fig. 6: Fastness properties of cotton dyed under optimized conditions

properties. Washing and light fastness properties are better than many of the commonly used direct and sulphur dyes. However, these may not be acceptable for high quality articles requiring very good fastness properties. Dry rubbing fastness is quite good. However, the wet rubbing fastness is poor.

## Experimental

### *Material and Equipment*

Eucalyptus bark

Lab-scale exhaust dyeing machine, for the dyeing process

Sodium sulphate, to promote dye exhaustion

Datacolor 600 spectrophotometer with software, for color measurement

Crockmeter, for testing rubbing fastness

Launder-o-meter, for testing washing fastness

Fadometer with xenon lamp, for testing light fastness

### *Optimization of Extraction Conditions*

Dead Eucalyptus bark was collected from the University of Agriculture, Faisalabad, without harming the trees. It was washed thoroughly with water and dried. It was then crushed into powder form and sieved through a 22 mesh size strainer for extraction [5]. In order to find out the optimum extraction conditions, a total number of 25 experiments were carried out at various temperatures with different stirring times as follows:

A set of 5 samples of crushed powder of Eucalyptus bark weighing 20 gm, dissolved in 200 ml distilled water in a beaker and subjected to stirring at room temperature for 20, 40, 60, 80 and 100 minutes, respectively.

A similar set of 5 samples subjected to stirring at 60 °C for 20, 40, 60, 80 and 100 minutes, respectively.

Another set of 5 samples subjected to stirring at 100 °C for 20, 40, 60, 80 and 100 minutes, respectively.

A set of 5 samples of crushed powder of Eucalyptus bark weighing 20 gm, soaked for overnight in 200 ml distilled water in a beaker and then subjected to stirring at room temperature for 20, 40, 60, 80 and 100 minutes, respectively.

Another set of 5 samples soaked for overnight in 200 ml distilled water in a beaker and then subjected to stirring at boil for 20, 40, 60, 80 and 100 minutes, respectively.

All the 25 dye extracts obtained from the above stated experiments were used to dye, in separate baths, 25 samples of cotton fabric weighing 4 gm each. Dyeings were carried out at 60°C, with 15:1 liquor to goods ratio for 60 minutes, using sodium sulphate to improve exhaustion. The dye extract which gave the maximum exhaustion was then selected for further experimentation in order to find out the optimum dyeing conditions.

### *Optimization of Dyeing Conditions*

Six samples of cotton fabric, weighing 2gm each, were dyed in six separate baths for 1 hour taking 30 ml of the dye extract in each bath at 40 °C, 50 °C, 60 °C, 70 °C, 80 °C and 90 °C, respectively. All of these dyeings were carried out in the presence of 1.5 gm sodium sulphate to promote exhaustion. To find out the optimum electrolyte concentration required for best degree of exhaustion, 10 more dyeings were carried out at the optimized temperature for 1 hour each with 0, 10, 30, 50, 70, 90, 110, 130, 150 and 170 g/ l sodium sulphate, respectively. To ascertain the optimum dyeing time, 6 more samples were dyed at the optimized dyeing temperature and electrolyte concentration for 20, 40, 60, 80, 100, and 120 minutes.

### *Fastness Testing*

Wash fastness of the samples dyed under the optimized conditions, was tested according to ISO 150, 105-CO3 method. The samples were washed in standard soap solution at 60 °C for 30 minutes, keeping liquor to material ratio as 1:50. Dry and wet rubbing fastness of the dyeings was tested according to ISO 150 105 X-12 method. Light fastness was tested according to ISO 150 105-BO2 method. The dyeings were exposed to xenon lamp for 24 hours at standard testing conditions.

## Conclusions

Extraction and dyeing conditions of a natural dye, from *Eucalyptus camaldulensis,* were optimized. The dye obtained displays fairly good saturation on cotton with medium to good fastness properties. It shall be interesting to see in the future work, whether the fastness properties can be further improved by mordanting or other fastness improvement techniques.

## References

1. H. Lathrop-Smith, *Natural Dyes*, James Lorimer and Company, (1978).
2. V. K. Gupta, *Indian Textile Journal*, **5**(108.) 15 (1998).
3. M. L. Gulrajani, *Natural Dyes and their Applications to Textiles*, Indian Institute of Technology, New Delhi, (1992).
4. Verma, *The Indian Textile Journal*, **108**(11). 82 (1998).
5. M. D. Teli, *Colorage*, **10**, 43 (2000).