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Dyeing Properties and Color Fabrics Using Natural Dye and Mordant

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ABSTRACT

An ecological approach has been obtained by using natural dyes and mordant for dyeing process. Fabrics were dyed using myrobalan extract as natural mordants and green dye. A red color was obtained by using theses mordants. The color of dyed fabrics was investigated in CIELab (L^*, a^* and b^*) and K/S values. Finally, all dyed fabrics were tested for wash and light fastness properties as per ISO standard test methods. The results of using biomordants for fabrics dyeing were comparable with that of metallic mordants in terms of color strength and fastness properties. Myrobalan extract as biomordant produced red color with medium fastness properties and thus offer full potential to replace metal salts in dyeing process. Prog. Color Colorants Coat. 11 (2018), 79-83© Institute for Color Science and Technology.

1. Introduction

Natural dyes or colorants are non-toxic, non-carcinogenic and bio-degradable materials and are very safe for applications in various scopes [1]. Also, natural dyes don't cause pollution and waste water problems [2]. As the present trend throughout the world is shifting towards the use of eco-friendly and biodegradable commodities, the demand for natural dyes is increasing day by day [3]. A revived interest in the use of natural dyes in textile coloration has been growing and there is pressing need for the availability of natural dye yielding plants [4]. This is a result of the stringent environmental standards imposed by many countries in a response to the toxic and allergic reactions associated with synthetic dyes [4, 5].

Ali et al. extracted new natural dyes from red prickly pear and used for dyeing wool with different mordants. The effect of mordant concentration on the color strength was investigated. The results show that the color strength decreases with the increase of mordant concentration. Antimicrobial activity of wool fabric dyed with this dye was tested according to diffusion agented. Test organisms as Escherichia coli, Bacillus subitilus, Pseudomonsaeruginosa and Staphylococcus aureus were used and the results indicated that the samples exhibited a high inhibition

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zone [6]. Prabhu et al. extracted Emblicaofficinalis G. dried fruit tannin and applied it as a natural mordant alone and in combination with metal mordant, namely copper sulphate, for dyeing on cotton and silk fabrics using natural dyes. The color strength, color-coordinates, wash and light fastnesses were also evaluated for cotton and silk fabrics with and without mordanting. The pre-mordanted cotton and silk fabrics gave better color strength, wash and light fastness than those dyeing obtained without mordanting. The total phenolic content of the extract was calculated [7]. Gusemi et al. studied the dyeing of wool with indicaxanthin, a natural dye extracted from fruits of Opuntiaficus-indica. The optimal conditions for dye extraction were to mix 50 g of Juice from cactus pears with 100 mL of 80% aqueous ethanol as solvent for dye extraction. Liquid chromatography was applied for the separation. Two main dyes were obtained, which were identified as indicaxanthin (75 mg per 50 g) and betanin (5 mg per 50 g). The effect of dye bath pH, salt concentration, dyeing time and temperature were studied. The optimal conditions for wool dyeing with indicaxanthin dye were 70 °C for 90 min with the pre-treatment of various metal salts as mordant [8, 9]. Chairat et al. extracted a new natural dye from dried fruit hulls of mangosteen as a natural dye for dyeing of cotton and silk yarn. The optimal conditions for dye extraction were 80 °C for 1 hour with a 15 % w/v citric acid solution in a 1:4 ratio of mangosteen powder to solvent. The results showed that the dyeing of cotton using the post-mordanting method with ferrous sulfate and calcium hydroxide not only provided better depth of shade but also provided better wash fastness and light fastness than with other mordants (alum; zinc tetrafluoroborate) or without mordant. Good fastness properties were also obtained using a post-mordanted silk with calcium hydroxide [10]. Arroyo-Figueroa designed an experiment to study the influence of mordant concentration on color behavior in cotton fabric dyed with cochineal extract. It was concluded that, when there was a larger concentration of metallic ions in the mordant, color fixation in the fabric was better, as there was less lightness in the red hue of the fabric. In addition, the more hydrogen ions present because of acids, the more intense is the red hue [11].

In this study, a natural mordant extracted from Combretaceae family, namely yellow myrobalan, that grown in Iran for the first time. The effect of biomordants on wool dyeing was investigated in terms of colorimetric data (a*, L* and K/S values) and fastness properties (light and wash fastnesses).

2. Experimental

2.1. Materials and Instrumentation

The yellow myrobalan used in this study was obtained from seven-years-old myrobalan tree grown in Khorasan and Yazad and harvested during 2017. The samples of yellow myrobalan were collected randomly from natural source. The wool fabrics were bleached with a solution containing 5 g/L of sodium carbonate and 3 g/L of non-ionic detergent (Labolene) under boiling for 2h, after which they were thoroughly rinsed and air dried at room temperature.

2.2. Sample Preparation and Dyeing Procedure

1 g fresh yellow myrobalan was extracted at 50 ºC for 15 min in 100 mL water. Solid residues were filtrated out to obtain clear dye solutions [12, 13]. Wool fabrics (1 g) were dyed in a dyeing apparatus using acetic acid (pH 4-5) and L:R=40:1. The buildup properties of the synthesized dyes on wool fabrics were studied by dyeing with dye solutions 0.1, 0.5, 1, 1.5, 2 and 4% owf. Dyeing was carried out by raising the dye bath temperature from 30 °C to 90 °C at the rate of 2 °C/min, holding at this temperature for 45 min and cooling down to 70 °C at the rate of 3 °C/min. The light, wash and perspiration fastnesses of each dyed fibers were determined according to ISO 105-B02:1994(E), ISO 105-C02:1989(E) and ISO 105-E02:1994(E), respectively.

3. Results and Discussion

Erminalia chebula, commonly known as black- or chebulic myrobalan, is a species of Terminalia, native to South Asia from India and Nepal east to southwest China (Yunnan), and south to Sri Lanka, Malaysia, and Vietnam [14]. This tree yields smallish, ribbed and nut-like fruits which are picked when still green and then pickled, boiled with a little added sugar in their own syrup or used in preserves. The seed of the fruit, which has an elliptical shape, is an abrasive seed enveloped by a fleshy and firm pulp. Seven types of fruit are recognized (vijaya, rohini, putana, amrita, abhaya, jivanti, and chetaki), based on the region where the fruit is harvested, as well as the color and shape of the fruit. Generally speaking, the vijaya variety is

preferred, which is traditionally grown in the Vindhya Range of west-central India, and has a roundish as opposed to a more angular shape [15, 16]. The yield of extraction from myrobalan was 34% which can be improved by using sophisticated techniques [17]. Mordants play very important role in imparting color to fabrics. The mordants used in different ratios gave varying shades. However, biomordants can serve with no or minimum environmental impact [18-20].

The silk fabrics dyed with green dyes at 90 °C for 1 h by using natural mordants that 20 g/L biomordants according to simultaneous mordanting method were evaluated. The dyeing process of silk fabrics is shown in Figure 1. The natural dye was applied to mordanting silk fabric at concentrations of 0.1, 0.5, 1, 1.5, 2 and 4% owf with liquor to good ratio of 40:1 at 90 °C. For color comparisons, color yield values and color coordinates (CIEL*a*b*) as well as visual evaluation should be taken into consideration to evaluate the samples accurately. The L*, a* and b* values of dyed fibers are 32.29, 42.67 and -6.45, respectively. Although a sample has maximum color yield, it may not be replaced with an alternative one due to having different nuances and visual appearance. For this reason, visual appearance of all samples was also mutually assessed and compared with each other in addition to color measurements. Sample dyed with almond shell without mordant was used as control sample in order to evaluate the effects of the mordants on color and fastness properties. Figure 2 shows K/S values for dyed fibers. Figure 2 illustrates the build up curves of natural dyes with three mordant from which it is apparent that they generally reach saturation at concentrations below 1.5% owf. The results show that using mixture of extraction as biomordant yields the highest build up. Fabric dyed with biomordants, which possess positive a* and negative b*, have blue-red hue [21, 22].

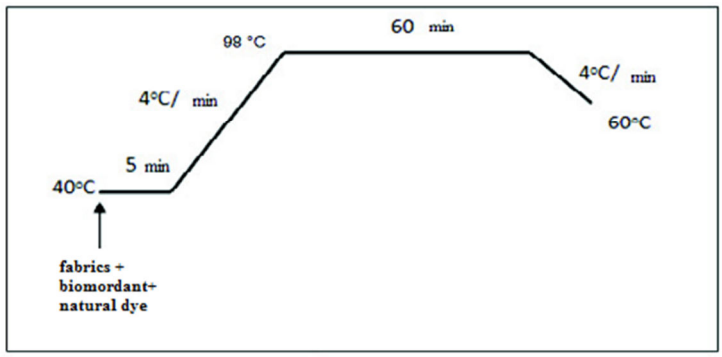

Figure 1: Dyeing process of fabrics.

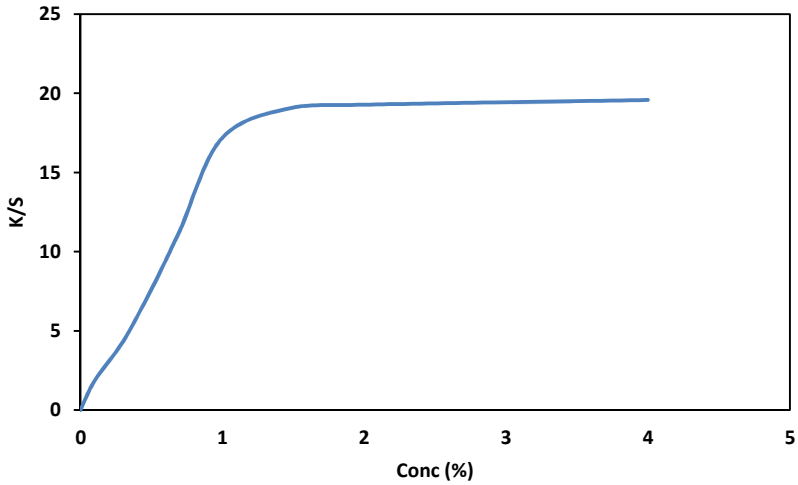

Figure 2: K/S values for dyed fibers with natural mordants.

Table 1: Wash and light fastness values.

Light fastness	Wash Fastness					
3	Change in color	Staining				
		Cotton	Nylon	Polyester	Wool	Acrylic
	3-4	4-5	5	5	4-5	4-5

The wash and light fastness of dyed fabrics was tested according to ISO 105-C02:1989(E) and ISO 105-B02:1994(E), respectively. Wash and light fastness values are summarized in Table 1. The fabrics dyed by biomordants have a color change of 3-4, staining of 4-5 and light fastness of 2-3. Accordingly, natural mordant causes a slight increment in color change. However, the color change and light fastness of myrobalan was higher than that of pomegranate biomordant. The dyed fabrics showed medium wash and light fastness. Fastness properties of dyed fabrics using myrobalan mordant were equal to other biomordants [23-25].

4. Conclusions

An environment friendly approach was presented for development of eco-friendly hues by myrobalan extract as natural mordants (biomordants). The aim of this study was to investigate dyeing properties of fabrics using biomordants such as myrobalan extract as renewable sources. Biomordants presented altogether different behavior and can serve as an alternative to metal mordants in terms of color characteristics and fastness properties which in turn depend on their concentration used. They also have no or minimum environmental impact and can be discharged into environment without any chemical treatment. More research analysis is required to enhance the biomordanting potential of these biomordants by proper dye standardization procedures to get wide range of ecofriendly shades of acceptable colorimetric and fastness properties.

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