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Extraction of Dye from Madder Plant (*Rubia tictorium* L.) and Dyeing of Wool

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Abstract: Madder plant is one of the most important plant sources for the manufacture of red pigments. In this study the dyeing substances present in madder plant were extracted by using the solvent extraction method. Woolen fabrics were dyed with both raw madder and extracted madder dye in a variety of concentrations. Spectrophotometric evaluations together with the colorimetric studies were carried out in order to compare the color strength of the extracted dye on woolen fabrics with the raw madder's color strength. It was found that, the color strength of extracted madder dye is more than raw madder.

Key words: Madder · Extraction · Dyeing · Color Strength

INTRODUCTION

Nowadays with the global concern over the use of eco-friendly and biodegradable materials, considerable research work is being undertaken around the world on the application of natural dyes in textile industry. The effluent problems of synthetic dyes occur not only during their application in the textile industry, but also during their manufacture and possibly during the synthesis of their intermediates and other raw materials [1-3]. Tedious extraction of dyestuff from the raw material, low color value and long dyeing times make the cost of natural dyeing considerably higher than dyeing with synthetic dyes [4, 5]. The use of natural dyes for textile dyeing purposes, decreased to a large extent after the discovery of synthetic dyes in 1856. As a result with a distinct lowering in synthetic dyestuff costs, the natural dyes were virtually unused at the beginning of twenties century. Nowadays in most of the countries, natural dyeing is practiced only as a handcraft and synthetic dyes are being used in all commercial dyeing processes. However With the worldwide concern over the use of eco-friendly and biodegradable materials, the use of natural dyes has once again gained interest [6, 7].

Madder plant, (*Rubia tinctorium* L.), is on of the most important plant sources for the manufacture of red pigments. Its root contains principally alizarin (1, 2-dyhydroxyanthraquinone) (Fig. 1) and several other anthraqinones in minor proportions such as purpurine, pseudo – purpurin, alizarin 2-methyl ester, Rubiadin, munjistin [8-11].

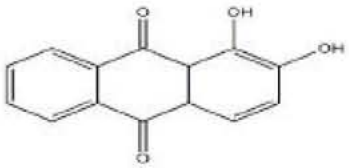

Fig. 1: Alizarin (1, 2-dyhydroxyanthraquinone)

In this work the solvent extraction method was used to extract the dye from madder roots. The color strength of the extracted dye on woolen fabrics was compared with the raw madder's color strength. The intent of present study was to show the higher efficiency of dyeing with using the proposed extraction method in comparison with traditional dyeing procedures.

Experimental

Materials: Madder plant, (*Rubia tinctorium L.*) was purchased from Iranian traditional natural dyers. Woolen fabrics (Iranian wool, construction: 82S/2 x 58S/1 3) Weight: 270 g/m), Ethanol.

Extraction: In extraction of *Rubia tinctorium* L. with soxhlet apparatus, ethanol was used as organic solvent. For evaporation of the solvent a rotary evaporator was used and the remained dry extract of dye was weighted. The total amount of extracted dye was found to be (27.5 %). For extraction in traditional method, powdered roots of *Rubia tinctorium* L. was mixed with 40 times as much water, boiled for 60 Minute and filtered while hot to obtain the extracted dyestuffs. The extracts left standing in a room until their temperature had dropped sufficiently and then filtered through a filter paper.

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Dyeing Procedure: The fabrics were mordanted prior to dyeing by treating with Potash-alum (potassium aluminum sulfate) ($Kal\ (SO_4)_2 \bullet 12H_2O$) at boil for 45 minutes. The liquor ratio was 1:40 and the mordant's concentration was 5% on weight of the fabrics .Both methods extracted dyes at concentrations of 10%, 30% and 70 % o.w.f. (on weight of fabric) were used for dyeing of the wool fabrics. The liquor-goods ratio was 40:1. Fabrics were introduced into the dyeing solutions at room temperature. Temperature was raised to the boil and dyeing continued at the boil for 60 minutes.

Measurement of Color Strength: The spectral reflectance of the dyed fabrics was measured using a (Texflash spectrophotometer, Datacolor Corp.). The K/S values were calculated by the Kubelka-Munk equation.

$$\left(\frac{K}{S}\right)_{\lambda} = \frac{(1-R_{\lambda})^2}{2\times R_{\lambda}} \quad (1)$$

Where R is the reflectance of dyed fabric at λmax, K is the absorption coefficient and S is the scattering coefficient. The relative color strengths (K/S values at λmax) were determined using the following equation:

$$Relative\ \ Color\ \ Strength = \frac{\left(\frac{K}{S}\right)_{Extracted}}{\left(\frac{K}{S}\right)_{Raw}} \quad (2)$$

Absorption Spectra: Absorption spectra of the dye solutions were measured using a (Cintra 10 uv-visible) spectrometer.

Color Fastness: Colorfastness to crocking and laundering were determined from standard test methods: ISO 105/X-1984(E) and ISO 105-CO1-1989(E) respectively. Color fastness to light was also evaluated according to ISO 105-B01:1989 (E) test method.

RESULTS AND DISCUSSION

Figure (1) shows the absorption spectra of a 10 g/l raw madder dye solution together with the spectra of a dye solution prepared by dissolving an equivalent amount of the extracted madder in water (2.75 g/l). It was observed that the absorbance of raw madder dye solution is considerably less than the absorption of its equal weight extracted madder dye solution.

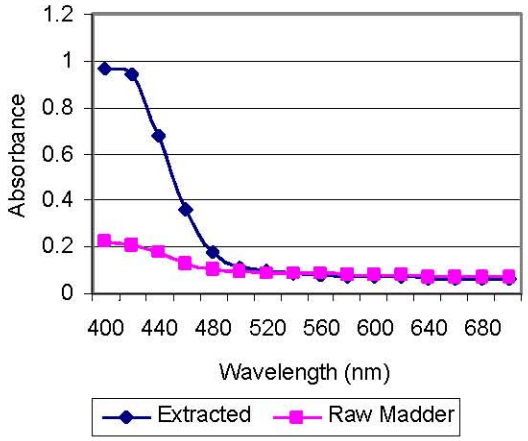

Fig. 2: Absorbance spectra of equivalent prepared dye solutions of raw (10g/l) and extracted (2.75g/l) madder

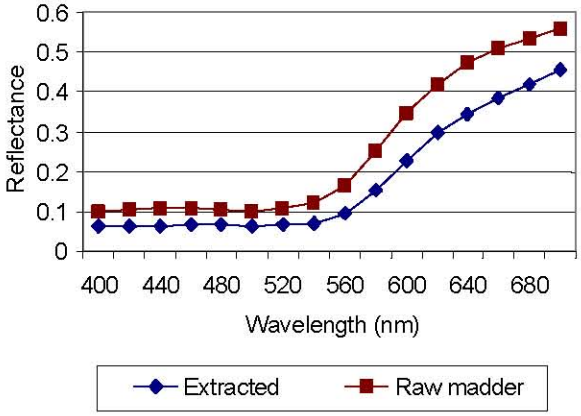

Fig. 3: Reflectance spectra of woolen fabrics, dyed with equivalent dye solutions of raw (10g/l) and extracted (2.75g/l) madder

Since the absorbance of solution is directly related to the concentration by Lambert -Beer's Law, therefore the dye content of extracted madder dye solution is more than its balance prepared dye solution of raw madder.

The Reflectance spectra of the woolen fabrics, dyed with equivalent prepared dye solutions of raw (10g/l) and extracted madder (2.75g/l) are also shown in Figure 2. As shown in this figure, the reflectance of the woolen fabric, dyed with raw madder, is more than the extracted madder dyed sample. Hence it can be concluded that the color strength of extracted form of madder is higher than its unextracted dyestuff. For better evaluation of dyed samples, their color quality is reported using the CIE L*a*b* color coordinates where, L* defines lightness; a* denotes the red/green value; and b* the yellow/blue value. As shown in Table (1) the lightness (L*) of raw

Table 1: Colorimetric parameters of dyed fabrics

No.	Concentration dye (gr/lit)	Dye	L*	a*	b*	C*	h^0	Relative Color Strength
1	3.33	Extracted	54.34	27.53	22.68	35.67	39.50	3.1
		Raw	66.69	21.80	16.28	27.21	36.77	
2	10	Extracted	41.98	28.91	20.29	35.32	35.08	1.85
		Raw	51.34	29.82	21.38	36.69	35.66	
3	23.33	Extracted	38.74	27.05	19.11	33.12	35.25	1.37
		Raw	43.10	31.92	22.42	39.01	35.10	

Table 2: Crocking, laundering and light fastness

			Colorfastness		
No.	Concentration dye (gr/lit)	Dye	Crocking fastness	Laundering fastness	Light fastness
1	3.33	Extracted	4	4-5	4-5
		Raw	4	4-5	4-5
2	10	Extracted	4	4-5	4-5
		Raw	4	4-5	4-5
3	23.33	Extracted	4	4-5	4-5
		Raw	4	4-5	4-5

madder dyed samples is more than samples dyed with extracted madder. On the other hand the relative color strength of extracted and raw madder was also calculated by using the Equation (1). It was found that, the color strength of extracted madder dye is more than raw madder. The results are given in Table 1.

There was not any difference between the fastness properties of dyed samples. Thus it can be claimed that extraction of madder dye has no impact on fastness properties of the dyed samples.

CONCLUSION

In this study, extraction of madder dye through solvent extraction method is described as a new approach to decrease the cost of madder dyeing via increasing the color strength of dyestuff. On the other hand nowadays most of the natural dyers are interested to use natural dye materials in the same ways used for synthetic dyes. Therefore extraction of natural dyes such as madder irrespective of its positive effect on color strength of dyestuffs may help to optimize the technical aspects of natural dyeing procedures.

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REFERENCES

1. Bechtold, T., A. Turcanu, E. Ganglberger and S.N. Geissler, 2002. J. Cleaner Production, 11: 499-509.
2. Rita, J., 1971. Natural dyes and home dyeing, (New York) (Dover Publication) (INC).
3. Jenny, D., 1994. The craft of natural dyeing, (Search Press Ltd).
4. Padmar, Vankar S., 2000. Resonance.
5. Robertson, M., 1973. Dyes from plants, (Litton Educational Publishing Inc).
6. Eom, S., D. Shin and K. Yoon, 2001. Ind. J. Fiber Text. Res., 26: 425-431.
7. Padhy, R.N. and D. Rathi, 1990. Text. Dyer. Printer. 23: 27-28.
8. Chenciner, R., 2000. Madder red: a history of luxury and trade, (Curzon press).
9. Goverdina, C.H., A. Derksena, Teris, Van Beeka, Æde de Groota, Anthony Capelleb, J. Chromatography A., 816(1998): 277-281.
10. Hasan Baydarr, 2006. Tahsin Karadogan, Turk J. Agric For., 30: 287-293.
11. Miliani, C., A. Romani and G. Favaro, 1998. Spectrochimica Acta Part A., 54: 581-588.