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Applications of Lac Dye Using Different Mordants on Leather

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Abstract. Lac dye aleuritic acid extracted from seed lac, when applied onto leather, using post-mordanting process showed good results. Among acetic acid, formic acid and alum, acetic acid at 0.1 M concentration proved to be the best mordant and gave excellent colour fastness to washing, light and rubbing and good tensile strength.

Keywords: lac dye, mordant, leather, aleuritic acid.

Introduction

Lac (*Laccifer lacca*) are small insects attached in large numbers to the plants and the trees and drain sap from the bark of host tree and secret lac resin (Kongkachuichay *et al.*, 2002a, 2002b). The resin is scrapped off and separated into shellac, wax and lac colour. Ovaries of the insect contain crimson fluid called lac dye which has two major components: laccaic acid A and B whose structures are shown in Figs. 1 and 2, respectively (Chairat *et al.*, 2008; Kamel *et al.*, 2005; Janhom *et al.*, 2004). Laccaic acid represent approximately 0.5-0.75 % by weight of stick lac (Lili *et al.*, 1999).

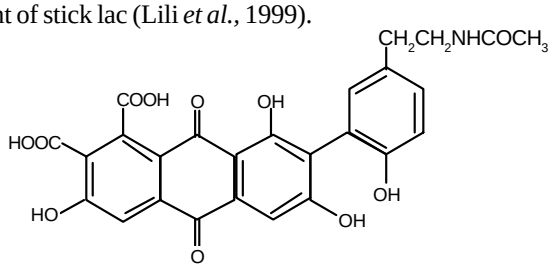

Fig. 1. Laccaic acid A

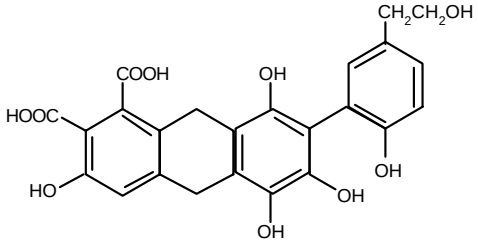

Fig. 2. Laccaic acid B

The deep interest of Pakistan leather industry in environment friendly leather processing techniques, has led to increased efforts to develop chrome-free tanning agents and to find ways to use natural dyestuffs, which previously had applications in the textile industry (Kamel *et al.*, 2007; Haroun, 2005; Kim *et al.*, 2003).

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Natural dyes have been used in textile processing since long but their application to natural leather has been extremely rare (Kumar and Sinha, 2004). Recent observations of the hazardous effects of benzidine compounds on mammals, even in very low amounts, have boosted the interest in natural dyestuffs.

Most of the natural red colour dyes have high solubility in water, therefore, the colour fastness to washing of the dyed leather is quite low (Rattanaphani *et al.*, 2007). In order to improve the colour fastness quality of the dyes, most dyeing processes are conducted using different mordants such as acetic acid, formic acid and alum. Depending on the type of dye and mordant used the colour fastness to washing is reported to be in the range of 3 to 5 for colour change, and 3-4 to 5 for staining (Waheed and Alam, 2004).

Materials and Methods

General procedure. Goat wet blue leather was used for the experiment and was dyed using the microdrum assembly with programmes to control temperature, time and speed of circulation of solution. The dyed leather samples were tested for colour fastness to washing using Launderometer, fastness to light using Xenon weatherometer, fastness to circular rubbing using rub fastness tester, for tensile strength material testing machine was used. Standard test methods for leather of the Society of Leather Technologists and Chemists (SLTC) were followed in all cases.

Leather, dyes and mordants. The leather used was collected from a local tannery of Sialkot. One kg of stick lac was ground into coarse powder. Ten litres of water were added and the solution was stirred and left standing for 24 h. After filtration, a reddish solution of lac dye was obtained. The lac dye solution was kept cold for further use. Three different types of mordants were used as follows: 0.1 M acetic acid, 0.1 M formic acid and 0.1 M alum.

Dyeing with lac dye using different mordants. Different mordants including 0.1 M acetic acid, 0.1 M formic acid and 0.1 M alum were used for lac dyeing of leather by the postmordanting method. The leather sample was first dyed with a solution of lac dye at 100 °C with a motor speed of 750 rpm per h, then the solution of mordant was added to lac dye solution in the ratio of 1:3 v/v for 30-50 min.

The concentration of the remaining dye solution and the amount of dye absorbed on the leather were calculated from the measured absorbance of dye solution at 520 nm (UV-VIS spectrophotometer, Spectronic Unicam) before and after dyeing of leather. The dyed samples were next tested for colour fastness to light, to washing and to rubbing and the tensile strength.

Dyeing by changing temperature and time. Leather (20 g) was dyed in a 2 litre solution of lac dye and 0.1 M acetic acid as previously described. The dyeing temperature was 60 °, 80 ° and 100 °C and the time was varied from 30 to 240 min. The dyed samples were then tested for colour fastness to washing, light, rubbing and the tensile strength.

Results and Discussion

Effect of mordants on dye absorption: Effects of different types of mordants on absorbance of dye by leather at different temperatures are shown in Table 1. Highest absorbance of dye was observed when acetic acid was used as mordant. The amount was approximately 15% and 30% higher than values obtained with formic acid and alum, respectively. The use of acetic acid as mordant offers an environment friendly alternative to the metal mordanted natural dyeing process (Vankar *et al.,* 2007).

Effect of mordants on physical properties. Comparison of dyeing techniques showed that post-mordanting method gave the highest depth of shade (Deo and Desai, 1999). Using this technique acetic acid, formic acid and alum were applied for the lac dyeing of leather. It was observed that type of mordants influenced the quality level and tensile strength of the dyed leather samples (Table 2). Use of acetic acid yielded the greatest tensile strength while 0.1 M alum showed the lowest overall tensile strength. Colour quality such as fastness to washing, fastness to light and fastness to rubbing of finished leather sample was excellent when acetic acid was used as mordant and poor with 0.1 M alum (Janhom *et al.,* 2006).

Table 1. Effect of mordants on the absorption of dye at different temperatures

Mordant	Absorbance		
	60 °C	80 °C	100 °C
Without mordant	1.992	1.868	1.743
0.1 M Acetic acid	0.772	0.697	0.498
0.1 M Formic acid	1.170	1.071	0.871
0.1 M Alum	1.619	1.494	1.245

Effect of dyeing conditions on quality of leather. Dyeing temperature and time are important parameters which influence the quality of dyed samples. Since acetic acid was observed to be the best mordant, the effect of temperature ranging from 60 ° to 100 °C for 30 to 200 min on dyeing with post-mordanting method using acetic acid as mordant was studied (Table 3). Almost all leather samples had excellent quality of staining on standard cloth and felt pad (level 5) except in case of rubbing, where the level decreased to 4-5. Neither dyeing temperature nor dyeing time had any effect on quality of staining; however, the dyeing time seemed to affect the colour change and fastness to light to some extent (Akalin *et al.,* 2004). Dyeing leather at 60 ° to 100 °C for longer than 80 min showed no further improvement in colour change and fastness to light, as the quality level slightly decreased after 80 minutes of dyeing.

Table 2. Effect of mordants on the quality and the tensile strength of leather at 100 °C for 60 min

Mordant	Quality level						Fastness to light	Tensile strength (MPa)
	Fastness to washing		Fastness to rubbing					
			Dry		Wet			
	Staining	Colour change	Staining	Colour change	Staining	Colour change	Colour change	
Without mordant	2 – 3	3	3 – 4	3	2	1 – 2	2 – 3	210.4
0.1M Acetic acid	5	5	5	5	5	5	4	290.5
0.1 M Formic acid	4 – 5	4	4 – 5	4	3 – 4	3	3 – 4	240.8
0.1 M Alum	4	4	4	3 – 4	3	2 – 3	3	235.4

Table 3. Effect of temperature and time of lac dye using acetic acid as mordant on the quality of leather

Dyeing temperature (°C)	Time (min)	Fastness to washing		Fastness to rubbing				Fastness to light
				Dry		Wet		
		Staining	Colour change	Staining	Colour change	Staining	Colour change	Colour change
60	30	5	4 – 5	5	4 – 5	4	4	3 – 4
	60	5	4 – 5	5	4 – 5	4	4	3 – 4
	80	5	4 – 5	5	4 – 5	4	4	3 – 4
	110	5	4	5	4	4	3 – 4	3
	150	5	4	5	4	4	3 – 4	3
	200	5	4	5	4	4	3 – 4	3
80	30	5	4 – 5	5	4 – 5	4	3 – 4	3 – 4
	60	5	4 – 5	5	4 – 5	4	3 – 4	3 – 4
	80	5	4 – 5	5	4 – 5	4	3 – 4	3 – 4
	110	5	4	5	4	4	4	3
	150	5	4	5	4	4	4	3
	200	5	4	5	4	4	4	3
100	30	4 – 5	5	5	5	4 – 5	5	4 – 5
	60	5	5	5	5	5	5	4
	80	5	5	5	5	5	5	4
	110	5	5	5	5	4 – 5	5	4
	150	5	5	5	5	4 – 5	4	4
	200	5	5	5	5	4 – 5	4	3

Effect of dyeing conditions on tensile strength. In the experiments performed to study the effect of dyeing temperature and time on tensile strength of leather using acetic acid as mordant it was found that dyeing temperature in the range of 60 °-100 °C and dyeing time of 30-90 min had little effect on tensile strength (Table 4).

Table 4. Effect of dyeing temperature and time on tensile strength of leather using acetic acid as mordant

Parameter	Tensile strength (MPa)
Time (min)	
30	275.4
40	278.2
60	290.5
70	280.6
90	279.4
Temperature (°C)	
60	265.4
70	270.3
100	290.5

Conclusion

The results indicate that acetic acid used as post mordant in dyeing with lac dye influence the properties of leather *viz.* as colour fastness to washing, fastness to light, fastness to rubbing and the tensile strength.

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