Volume : 3 | Issue : 3 | March 2014 • ISSN No 2277 - 8160

Research Paper | Textile

Optimization of Dyeing Conditions for Acid Green 16 on Mulberry Silk Waste/Wool Blended Fabric

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ABSTRACT

Silk and wool are hydrophilic in nature, wetted by water and are dyed with either acid or basic dyes through the formation of ionic bonds (salt linkages). The present investigation was carried out to optimize the dyeing conditions for Acid Green 16 on mulberry silk waste/wool blended fabric. Dyeing conditions viz. pH, time and concentration was optimized on the basis of CIE Lab, K/S values and wash fastness grades. It was found in the study that Optimum dyeing conditions were pH 5 for 80 minutes at 90°C with 4 percent dye concentration.

KEYWORDS: Mulberry silk waste, wool, optimized condition, pH, acid dye.

1. Introduction

Dyeing is a method for colouring a textile material in which a dye is applied to the substrate in a uniform manner, to obtain an even shade, with the performance and fastness appropriate to its final use. The process of dyeing is carried out in a variety of ways depending on the specific dye utilized as well as the properties of the substrate. Acid dyes are water-soluble anionic dyes that are applied to nitrogeneous fibers such as wool, silk, nylon and modified acrylic. Attachment of dye to the fiber is attributed at least partly to salt formation between anionic groups in the dyes and cationic groups in the fiber. Acid dyes are not substantive to cellulosic fibers. The acid dyes were probably originally so named because of the presence of one or more sulphonic acid or other acidic groups in their molecules. The term applies to an application class rather than a chemical class. Since acidic groups are also present in many mordant, direct and reactive dyes but their presence is not a distinguishing feature.

2. Material and Method

Hand woven blend of mulberry silk waste/wool in the ratio of 65:35 and various chemicals were used in the study.

Experiments were conducted to determine optimum values of four variables, viz pH of dyeing solution, dyeing temperature, dyeing time and dye concentration. These variables were optimized for both the groups of dyes on the basis of CIE Lab, K/S values and wash fastness grades. The recipe for dyeing was as follows:

Dye	:	x % (owf)
Liquor ratio:		1:30
Dyeing pH :		6-7
Sulphuric acid	:	4%
Sodium sulphate:		20g/l
Temperature	:	70°C-90°C
Time	:	60-80 minute

Optimized amount of stock solution was taken to prepare the dye bath to which required amount of sulphuric acid and sodium sulphate was added. The fabric was entered at 40°C and the temperature of the dye bath was raised to 90°C. Fabric was kept at 90°C for 30 minutes. Again after 20 minutes remaining sulphuric acid was added to the dye bath. Dyeing was carried out for another 10 minutes. After dyeing soaping of fabric was done and then the fabric was thoroughly rinsed in luke warm water followed by rinsing in cold water and were dried in shade.

2.1 Evaluation of CIE Lab values

The colour of dyed samples was measured numerically through computerized colour matching system. The CIE Lab colour space uses L*, a *, b*was calculated for all the dyed samples. The relative colour strength of dyed fabrics expressed as K/S was measured by light reflectance technique using the Kubelka-Munk equation. The reflectance of dyed fabrics was measured on Premeir Colorscam.

K/S = (1-R) 2/ 2R

Where K and S are constants associated with the light absorption and scattering of the fabric respectively. R is the reflectance of the dyed fabric measured at the wavelength of maximum light absorption expressed in fractional form.

2.2 Evaluation of colour fastness properties

For determining the washing fastness of dyed samples.Test-2 described in the Indian Standard IS: 3361-1979 was used.

3. Result and Discussion

3.1 Optimization of dyeing pH for Acid Green 19

The colour parameters of the dyed mulberry silk waste/wool blended fabric with Acid Green 19 at different pH values were evaluated. Table 1 show that the value of L was highest (52.459) at pH 5 and then it dropped to 51.541 and 50.416 when pH was increased to 6 and 7 respectively. The negative value of a (-15.538) and b (-8.732) of the sample dyed at pH 5, indicated that the sample was less green and less blue as compared to that when dyed at pH 6 and 7. The value of K/S observed was highest (5.310) for the sample dyed at 5 pH indicating that the dye absorption was maximum at pH 5 as compared to the samples dyed at pH 6 and 7.

Table 1 Optimization of dyeing pH for Acid Green 19 on the basis CIE Lab and K/S values

pH	Wavelength (nm)	L	a	b	K/S values
5	520	52.459	-15.538	-8.732	5.310
6	520	51.514	-15.560	-9.978	4.923
7	520	50.416	-15.746	-10.342	4.298

Data furnished in table 2 shows the wash fastness results of Acid Green 19 samples. All the samples dyed at 5, 6 and 7 pH showed good grades for colour change, whereas slight staining was observed on wool fabric and noticeable to slight staining was observed on silk fabric. Hence pH 5 was considered optimum for dyeing the fabric with Acid Green 19 as the dye absorption was maximum at pH 5 and the wash fastness grades were same for all the pH.

Table 2 Optimization of dyeing pH for Acid Green 19 on the basis of wash fastness

pH	CC	C S	
		W	S
5	4	4	3/4
6	4	4	3/4
7	4	4	3/4

3.2 Optimization of dyeing temperature for Acid Green 19

The CIE Lab and K/S values regarding the optimization of temperature are shown in table 3. Data in the table showed that the sample dyed at 90°C had the highest value of L (53.876) which means that it was darker as compared to the samples dyed at 70°C and 80°C. In terms of a value for the samples dyed at 90°C it was found to be more green as depicted by its higher negative a value (-16.147) as compared to dyeing temperature 70°C (-15.890) and 80°C (-15.543). As far as b value was concerned, more bluish value was depicted by the negative value (-11.498) of the sample dyed at 80°C however not much difference was found between the b values of samples dyed at 70°C and 90°C. It was observed form the table 3 that K/S value increased with the increase in the dyeing temperature and it was observed maximum (7.363) for the samples dyed at 90°C.

Table 3 Optimization of dyeing temperature for Acid Green 19 on the basis of CIE Lab and K/S values

Temperature (°C)	Wavelength (nm)	L	a	b	K/S values
70	520	50.431	-15.890	-11.452	4.924
80	520	51.669	-15.543	-11.498	5.231
90	520	53.876	-16.147	-11.453	7.363

As far as the wash fastness grades are concerned data presented in table 4 reveals that the samples dyed at 70°C and 80°C possessed good wash fastness in terms of colour change and the dyed sample showed slight staining on both wool and silk fabrics. Whereas, the sample dyed at 90°C showed good grade for colour change and slight staining on wool fabric whereas slight to noticeable staining on silk fabric. Thus, 90°C temperature was considered optimum.

Table 4 Optimization of dyeing temperature for Acid Green 19 on the basis of wash fastness

Temperature (°C)	CC	C S	
		W	S
70	4	4	4
80	4	4	4
90	4	4	4/3

3.3 Optimization of dyeing time for Acid Green 19

It could be investigated from table 5 that value of L was highest (51.980) the sample dyed for 80 minutes of dyeing time which indicated that this sample was darker as compared to the samples dyed for 60 and 70 minutes where the brightness decreased. The value of a increased with the increase in dyeing time. The value of a observed was -14.876, 15.609 and -16.121 at dyeing time 60, 70 and 80 minutes respectively, which indicated that the sample was greenest when the dyeing time was 80 minutes. The value of b was found to be maximum (-10.645) when the sample was dyed for 80 minutes which indicated its maximum blueness. Sample was less blue when dyed for 60 and 70 minutes with b value -9.980 and -10.143 respectively.

Looking into K/S value of samples dyed for 60, 70 and 80 minutes of dyeing time showed that the sample dyed for 80 minutes had the highest value of K/S with mean value of 5.231. Whereas the value of K/S was observed 4.924 and 4.934 for the samples dyed for 60 and 70 minutes respectively.

Table 5 Optimization of dyeing time for Acid Green 19 on the basis of CIE Lab and K/S values

Time (min)	Wavelength (nm)	L	a	b	K/S values
60	520	50.765	-14.876	-9.980	4.924
70	520	51.078	-15.609	-10.143	4.934
80	520	51.980	-16.121	-10.654	5.231

The wash fastness grades for the samples dyed for 60, 70 and 80 minutes using Acid Green 19 has been furnished in table 6. It was observed that irrespective of increase in time duration the grades remained good for colour change after washing and slight staining was recorded on wool fabric whereas, noticeable to slight staining was found on the silk fabric for all dyeing times. Although wash fastness results were same at all the dyeing times but the dye absorption was found maximum at 80 minutes, hence it was considered optimum for further work

Table 6 Optimization of dyeing time for Acid Green 19 on the basis of wash fastness

Time (min)	CC	C S	
		W	S
60	4	4	3/4
70	4	4	3/4
80	4	4	3/4

3.4 Optimization of dye concentration for Acid Green 19

It is apparent from the table 7 that the sample dyed at 6 percent dye concentration showed the highest value of L (55.654), which was the indicator of the darkness and brightness of the dyed samples. The value of a and b was recorded as -15.729 and -12.987 respectively, it means that the sample dyed at 6 percent concentration were more green and more blue. The value of K/S also showed the increasing trend with the increase in dye concentration.

Table 7 Optimization of dye concentration for Acid Green 19 on the basis of CIE Lab and K/S values

Concentration (%)	Wavelength (nm)	L	a	b	K/S values
1	520	51.841	-12.253	-9.490	5.297
2	520	51.897	-12.558	-10.090	7.363
3	520	52.765	-13.564	-11.321	13.303
4	520	53.435	-13.870	-12.654	19.012
5	520	54.534	-15.457	-12.765	24.010
6	520	55.654	-15.729	-12.987	32.340

It was observed from the table 8 that the wash fastness grades remained same for the samples dyed at 1, 2, 3 and 4 percent dye concentrations. The wash fastness grades were good for colour change and slight staining was observed on both wool and silk fabrics. The sample dyed at 4 percent dye concentration showed higher value of CIE Lab as compared to the samples dyed at 1, 2 and 3 percent dye concentration. The observed value for L at 4 percent dye concentration which indicated its brightness was found to be 53.435. Greenness was evaluated in terms of a value and was found to be -13.870 whereas blueness was observed as b value (-12.654). The colour strength measured in terms of K/S was observed as 19.012. Further it was concluded from the table 4.22 that the wash fastness grades decreased after further increase in percent dye concentration. For 5 and 6 percent dye concentration the observed wash fastness grades were fair to good for colour change and noticeable to slight staining was observed on both wool and silk fabrics. Considering the all above results, 4 percent dye concentration was optimized as optimum dye concentration.

Table 8 Optimization of dye concentration for Acid Green 19 on the basis of wash fastness

Concentration (%)	CC	C S	
		W	S
1	4	4	4
2	4	4	4
3	4	4	4
4	4	4	4
5	3/4	4	3/4
6	3/4	3/4	3/4

Conclusion

In the present investigation an attempt was made to give a clear picture about the dyeing of mulberry silk waste/wool blended fabric with Acid Green 16. From the results of the present study it can be concluded that the mulberry silk waste/wool blended fabric can be dyed easily and effectively. The value addition of mulberry silk waste/wool blended fabric through dyeing, can lead to its diversified uses in the apparel and home textiles.

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