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A Study on Dyeing of Cotton Knit Fabric with Reactive dye in variable Liquor Ratio

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Abstract

The aim of this work is to find out the deviations between quality parameters such as spectrophotometric evaluation, colour fastness to washing, and rubbing of reactive dyed fabric samples in different water amounts. In this work, the cotton knit fabric samples were dyed with a combination of three reactive dyes such as Bezaktiv Yellow S-Matrix 150, Bezaktiv Red S-Matrix 150, Bezaktiv Blue S-Matrix 150 in three different shade percentages e.g. 0.385%, 1.344%, and 4.38%with four different water quantities, for example, 1:4, 1:6, 1:8 and 1:10. The findings show that the spectrophotometric evaluation, colorfastness to washing, and rubbing are almost similar in all the variations in water volume. The experimental works have been done at R. H Corporation (CHT BEZEMA) in Bangladesh.

Keywords: Reactive dyeing, Material to Liquor Ratio, Spectrophotometric Evaluation.

1. Introduction

The low liquor ratio dyeing process imposes beneficial dyeing compared to the conventional dyeing method, without conjugating any agglomeration effects and exhibiting any adverse outcome on the fastness grade of the dye. This dyeing process has been considered as a distinguished method because of its minor influence on the environment. Generally, dyestuffs having the characteristics of superior affinity or strike rate for fibers require plentiful liquor in dye bath for leveled dyeing. Higher liquor ratio dilutes the bath by creating space between dyes molecules which interrupts any two molecules to reach the same point on the fiber surface at the same time. That's the reason of producing leveled shade. A low liquor ratio contains a greater concentration of dye molecules in bath. Several amounts of dye molecules attempt to diffuse the same point on the fiber that enhances the trike rate, causing defective shade [1-8]. Once the knit fabric was dyeing in exhaust process in Liquor ratio 1:20. In the course of time, the liquor ratio has been reduced from 1:20 to 1:8 or 1:10. Now-a-day, each dyeing industry wants to ensure the motive of saving a huge amount of water in dye bath, by reducing the liquor ratio. The objective of this work is to reduce the Material: Liquor ratio in lab-scale dyeing of knit fabric.

2. Materials and Methods

Scoured and bleached, 100% cotton single jersey knitted fabric with160 GSM was used for exhaust dyeing. Dyeing was carried out on a new Smart Dyer machine made by the company, XIAMEN RAPID CO. LTD, China. For pipetting, Single Channel Electronic

Pipette made by METTLER TOLEDO, was used

2.1. Dyeing Procedure

In this comparative study, regular scoured bleached fabric samples were dyed with reactive dyes from Switzerland, such as Bezaktiv Yellow S-Matrix 150, Bezaktiv Red S-Matrix 150, Bezaktiv Blue S-Matrix 150, **etc.** were used during dyeing. Table 1shows the combined shade percentages with the name of the dyes and shades according to liquor ratio. The samples were dyed according to the dyeing recipe in the laboratory dyeing machine. The dyeing was carried out at 60^0 C for 60 minutes. After dyeing the fabric samples were washed and neutralized by Acetic acid. Finally, Soaping was done at 98^0 C temperature for 20 minutes.

2.2. Shade Evaluation Procedure

Color Matching Cabinet (Verivide, made by James H. Heal & Co. Ltd., England) was used to check the shade match with the standard under the D_{65} light source.

2.3. Spectrophotometric Evaluation procedure

The Spectrophotometric evaluation was done by the color measuring instrument DATACOLOR 650 was used.

2.4. Colorfastness to wash and Rubbing procedure

The colorfastness to wash (color change and color staining) was done in WASHTEC-P (made by ROACHES INTERNATIONAL LTD., England) following the test method, **ISO 105 C06**and another fastness test, color-fastness to rubbing was performed in Crock master (made by James H. Heal & Co. Ltd., England) according to the test method, **ISO 105 X12.** A Grey-scale was used for the assessment of colour change and staining.

3. Results and Discussion

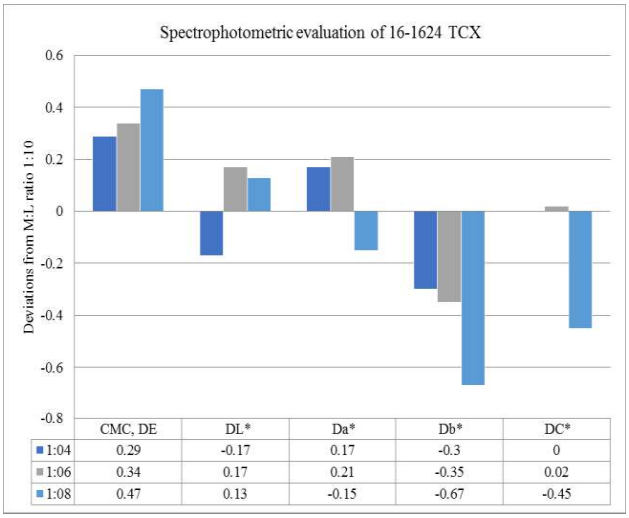
Table 1: The dyes with shade percentages and according to M:L ratio.

Shade / Pantone	Recipe (%)	Shades according to M:L Ratio			
		1:4	**1:6**	**1:8**	**1:10**
16-1624 TCX	Bezaktiv Yellow S-Matrix 150 0.184 Bezaktiv Red S-Matrix 150 0.198 Bezaktiv Blue S-Matrix 150 0.003				
18-0515 TCX	Bezaktiv Yellow S-Matrix 150 0.724 Bezaktiv Red S-Matrix 150 0.120 Bezaktiv Blue S-Matrix 150 0.500				
19-2520 TCX	Bezaktiv Yellow S-Matrix 150 0.520 Bezaktiv Red S-Matrix 150 3.000 Bezaktiv Blue S-Matrix 150 0.860				

3.1. Shade Evaluation

3.2. Spectrophotometric Evaluation

3.2.1. Spectrophotometric Evaluation of Shade 16-1624 TCX

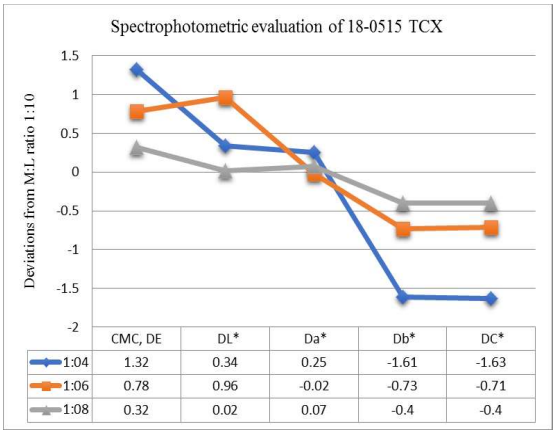


	CMC, DE	DL*	Da*	Db*	DC*
1:04	0.29	-0.17	0.17	-0.3	0
1:06	0.34	0.17	0.21	-0.35	0.02
1:08	0.47	0.13	-0.15	-0.67	-0.45

Figure 1: Deviations of the shade of samples as compared to M: L ratio 1:10.

From the bar diagram in figure 1, it was observed that the deviations of total color DE, lightness DL*, CIE lab values Da*, Db*, chroma Dc* and hue DH* of the dyed samples with Material: Liquor (M:L) ratio such as 1:4, 1:6 and 1:8 as compared to the sample dyed with M:L ratio 1:10. It was clearly seen that the total color deviations are increasing with the increment of the amount of water as the values are 0.29, 0.34, and 0.47 for 1:4, 1:6, and 1:8 respectively. The deviation of lightness DL* values of samples are -0.17, 0.17, and 0.13 which indicates that the samples dyed with M:L ratio1:4 are darker than the standard sample which is dyed with a 1:10 M:L ratio. The other two samples are lighter than the standard sample. Similarly, CIE lab value for reference Da* values are 0.17, 0.21, -0.15 which indicates that the 1:4 and 1:6 dyed samples are redder and 1: 8 dyed sample is greener than the standard sample Db* values are -0.30, -0.35, -0.67 of dyed samples with M:L ratio 1:4, 1:6 and 1:8 respectively which indicate that the samples are greener than the standard sample. The chroma differences Dc* are 0, 0.02, -0.45 which indicates the 1:4 dyed sample has no difference in depth and the 1:6 dyed sample is brighter, and the 1:8 dyed sample is duller than the standard sample.

3.2.2. Spectrophotometric Evaluation of Shade 18-0515 TCX



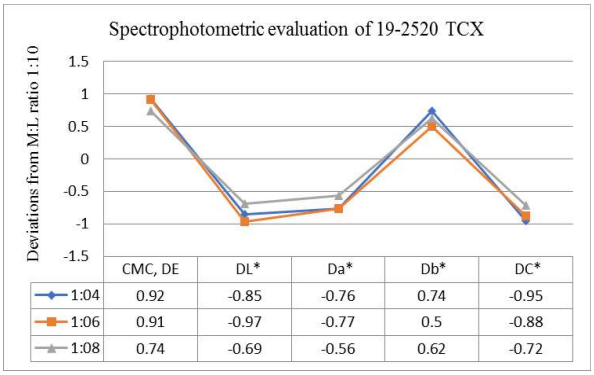
	CMC, DE	DL*	Da*	Db*	DC*
1:04	1.32	0.34	0.25	-1.61	-1.63
1:06	0.78	0.96	-0.02	-0.73	-0.71
1:08	0.32	0.02	0.07	-0.4	-0.4

Figure 2: The Anomalies of the shade of samples as compared to M: L ratio 1:10

Figure 2 shows the line diagram of the deviations of color difference DE, lightness DL*, CIE lab values Da*, Db*, chroma Dc* and hue DH* of the dyed samples with material: liquor (M:L) ratio for example 1:4, 1:6 and 1:8 as compared to the sample dyed with M:L ratio 1:10. It was clearly seen that the total color deviations are decreasing with the increase of the amount of water as the values are 1.32, 0.78 and 0.32 for 1:4, 1:6 and 1:8 respectively. The difference of lightness DL* values of samples are 0.34, 0.96 and 0.02 which indicate that the samples dyed with M:L ratio1:4, 1:6 and 1:8 are lighter than the standard sample which is dyed with a 1:10 M:L ratio. Similarly, CIE lab values for reference Da* values are 0.25, -0.02, 0.07which indicates that the 1:4 and the 1:6 dyed samples are redder and the 1: 8 dyed sample is greener than the standard sample. Similarly the Db* values are -1.61, -0.73, and -0.40 of dyed samples with M:L ratio 1:4, 1:6, and 1:8 respectively which

indicates that the samples are greener than the standard sample. The chroma differences Dc* are -1.63, -0.71, and -0.4 which indicate the samples are brighter than the standard sample.

3.2.3. Spectrophotometric Evaluation of Shade 19-2520 TCX



	CMC, DE	DL*	Da*	Db*	DC*
1:04	0.92	-0.85	-0.76	0.74	-0.95
1:06	0.91	-0.97	-0.77	0.5	-0.88
1:08	0.74	-0.69	-0.56	0.62	-0.72

Figure 3: Difference of the shade of samples as compared to M: L ratio 1:10.

The line diagram in figure 3 shows the deviations of color difference DE, lightness DL*, CIE lab values Da*, Db* and chroma Dc* of the dyed samples with material: liquor (M:L) ratio such as 1:4, 1:6 and 1:8 as compared to the sample dyed with M:L ratio 1:10. It was clearly seen that the total color deviations are decreasing with the increment of the amount of water as the values are 0.92, 0.91, and 0.74 for the samples dyed with M:L ratio 1:4, 1:6, and 1:8 respectively. The deviation of lightness DL* values of samples are -0.85, -0.97, and -0.67 which indicates that the samples dyed with M:L ratio:4, 1:6, and 1:8 are darker than the standard sample which is dyed with a 1:10 M:L ratio. Likewise, CIE lab values for reference Da* values are -0.76, -0.77, -0.56which indicate that the 1:4 1:6 and 1:8 dyed samples are greener than the standard sample. Again the Db* values are 0.74, 0.50, 0.62 of dyed samples with M:L ratio 1:4, 1:6, and 1:8 respectively which indicates that are yellower than the standard sample. The chroma differences Dc* are -0.95, -0.80 and -0.72 which indicate that the 1:4, 1:6 and 1:8 dyed samples are brighter than the standard sample.

3.3. Colorfastness to wash and Rubbing fastness Evaluation

Table 2 shows the greyscale rating of wash and rubbing fastness of the samples dyed with different M:L ratios such as 1:4, 1:6, 1:8 and 1:10. It is observed that almost all the samples are very good with rating 4-5 in wash fastness in staining of colour to different fibers such as Diacetate, Cotton, Nylon, Polyester, Acrylic and Wool of the multifiber fabric.

The dry and wet rubbing fastness's of the samples of 16-1624 TCX were very good to good with 4-5 and 4 ratings that indicates the samples are very good and good respectively, The samples of 18-0515 TCX were 4-5, 4 and 3-4 and 3 ratings respectively which indicates that the samples were very good to good. Similarly, the 19-2520 TCX samples were 4 and 2-3 ratings respectively that indicate the samples were very good in dry rubbing but fair in wet rubbing as the sample's colour depth was more than the other samples.

Table 2: The Grey scale ratings of colour fastness to wash and rubbing samples.

Shade / Pantone	Liquor Ratio	Color Fastness to Wash						Color Fastness to Rubbing	
		DIACETAE	COTTON	NYLON	POLYESTR	ACRYLIC	WOOL	Dry	Wet
16-1624 TCX	1:4	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4
	1:6	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4
	1:8	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4
	1:10	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4
18-0515 TCX	1:4	4-5	4-5	4-5	4-5	4-5	4-5	4-5	3-4
	1:6	4-5	4-5	4-5	4-5	4-5	4-5	4-5	3
	1:8	4-5	4-5	4-5	4-5	4-5	4-5	4	3
	1:10	4-5	4-5	4-5	4-5	4-5	4-5	4	3
19-2520 TCX	1:4	4-5	4	4-5	4-5	4-5	4-5	4	2-3
	1:6	4-5	4	4-5	4-5	4-5	4-5	3-4	2-3
	1:8	4-5	4	4-5	4-5	4-5	4-5	4	2-3
	1:10	4-5	4	4-5	4-5	4-5	4-5	4	2-3

4. Conclusion

From the above discussions it can be revealed that with the increment of M:L ratio 1:4, 1:6, 1:8 and 1:10 during lab-scale dyeing, the total color difference is matched which indicates that the DE values are in limit with one another in spectrophotometric evaluation. The wash and rubbing fastness are also almost similar. It can be concluded that on lab-scale the amounts of water do not create any difficulty in shade difference, wash, and rubbing fastness.

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