Southeast University Journal of Textile Engineering, Vol. 1, No. 1, January 2021, ISSN 2709-9598

Effects of Liquor Ratio on Cotton Knit Fabric with Reactive Dye

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Abstract
This research specifies the effect of liquor ratio on the different fastness behavior likely, rubbing, wash, water, perspiration and saliva as well as indicating how liquor ratio influences the behavior of reflectance, color fastness and the GSM. Here, six different liquor ratios (1:5, 1:10, 1:15, 1:20, 1:25, and 1:30) were used and 2% shade was applied with above liquor ratios. Rubbing fastness results for wet was found poor and for fastness to water in case of staining scale value was moderate; however for saliva the result was very good for all ratios. The most interesting part was that the color strength declined slowly if liquor ratios increased gradually, but there was no influence on GSM for changing the liquor ratio.

Keywords: Reactive Dyeing, Liquor ratio, Color Fastness, GSM and Color Strength.

1. Introduction
Dyeing is a complicated process- where some variables are involved. Material to liquor ratio (MLR) plays the most vital role in coloration, basically machines with MLR from 1:4 to 1:10 mostly used, but it is preferable for a machine operating with least possible liquor ratio without affecting the dyeing quality. As MLR increases, the depth of color or strength of the color decreases. So to get it right first time dyeing for such typical shade, appropriate MLR should be taken. However, decrease in color strength may be avoided by increasing the color shade percentage [1].

The process of dyeing is mainly governed by the type of fabric, type of dye, type of machine; other parameters also influence the process like temperature, time, auxiliaries, pH of the liquor and liquor ratio. Any small variation of these factors may create problem in the color reproducibility, although it is achievable to get reproducibility in the outcomes [1-2].

Another research analyzed the influence of process parameters on cotton coloration with reactive dye and a great range of application was achieved for various reactive dyes [3]. Concentration of dye, liquor ratio and time of coloration have direct effects on the depth of the resulting shades, whereas reactive dyeing shows better exhaustion at low liquor ratio [4].

This article has emphasized on the effects of material to liquor ratio on various fastness property to rubbing, perspiration, wash, water and saliva; whereas the impact of liquor ratio on reflectance, color strength and GSM have also been analyzed.

2. Material and Methods
100% cotton knit fabric with the construction of 2×2 rib was used as sample throughout the experiment. Pretreatment was carried out through scouring, bleaching and enzyme treatment in a sample dyeing machine manufactured by LABTEC (IR-24) by Taiwan and that was also used for dyeing. Color fastness to rubbing was measured by the ISO-105-X12 test method and fastness to wash was measured by the ISO-105-C06-A2S test method. Color fastness to perspiration was measured by method of ISO-105-E04 and method ISO-105-E01 was for fastness to water and ISO-105-E04 was for fastness to saliva. The values of reflectance and color strength were taken from spectrophotometer, data color 650TM (manufactured by data color, USA). The GSM was measured by GSM cutter and weight balance. However,

pretreatment was done at 98 °C for 45 minutes at pH 11.5 according to the recipe and enzyme treatment was also carried out at 55 °C for 60 minutes at pH 5.5. After that reactive dyeing was performed with 2% shade at 60 °C for 60 minutes and for this process six liquor ratios were taken separately which were 1:5, 1:10, 1:15, 1:20, 1:25 and 1:30 respectively at pH 11.5. After that, color fastness to rubbing, washing, perspiration, water and saliva were measured. The reflectance and color strength were also measured after dyeing by spectrophotometer. On the other hand, the GSM values were taken after dyeing with different liquor ratios as well as the grey, scoured-bleached and enzyme.

Table 1. Recipe of pretreatment process.

Process	Chemicals	Amount (g/L)	Temperature (^{0}C)	Time (minute)	pH
Scouring & bleaching	Wetting agent	1	98	45	11.5
	Sequestering agent	0.5			
	Anti creasing agent	0.5			
	Stabilizer	0.3			
	NaOH	1.8			
	H_2O_2	1.7			
Enzyme	Enzyme	0.3	55	40	5.5
	Bio-polishing	0.25			
	Wetting agent	1			
	Sequestering agent	0.5			
	Anti creasing agent	0.5			

Table 2. Recipe of dyeing process.

Process	Liquor ratio	Chemicals	Amount (g/L)	Temperature (^{0}C)	Time (minute)	pH
Dyeing	1:5, 1:10, 1:15, 1:20, 1:25, 1:30	Wetting agent	1	60	60	11.5
		Sequestering agent	0.5			
		Anti creasing agent	0.5			
		NaCl	50			
		Na_2CO_3	15			

3. Results and Discussion

3.1 Color fastness to rubbing

Table 3. Color fastness to rubbing at different conditions.

Liquor Ratio	Color fastness to rubbing			
	Dry		Wet	
	Width	Length	Width	Length
1:5	4-5	4-5	2-3	3-4
1:10	4-5	4-5	2-3	2-3
1:15	4-5	4-5	2-3	2-3
1:20	4-5	4-5	2-3	2-3
1:25	4-5	4-5	2-3	2-3
1:30	4-5	4-5	2-3	2-3

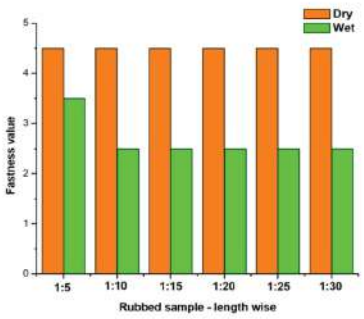


Figure 1. Color fastness to rubbing – length wise.

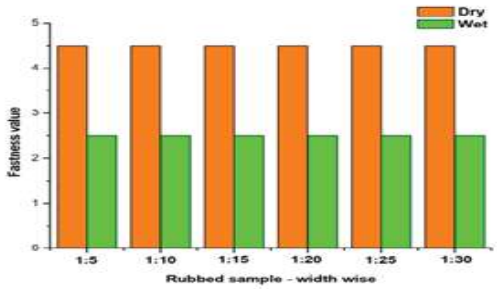


Figure 2. Color fastness to rubbing – width wise.

From the above figures for color fastness to rubbing it is clear that both length and width wise, in case of dry fastness, values are constant in 4-5 but for 1:5 MLR, the length wise fastness to wet is 3-4 and the rest are remaining in poor fastness i.e. 2-3. But another study revealed that increasing in the liquor ratios indicated better wet and dry rubbing fastness to both of shade change and staining [5].

3.2 Color fastness to wash

Table 4. Color fastness to wash of dyed fabrics.

Color fastness to wash	
Change in color	**Staining**
4-5	4-5
4-5	4-5
4-5	4-5
4-5	4-5
4-5	4-5
4-5	4-5

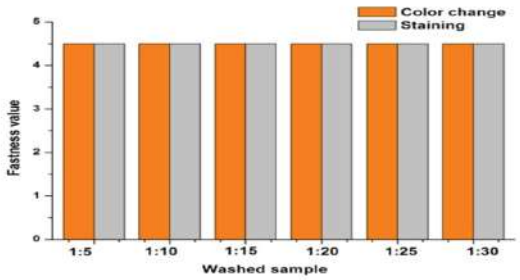


Figure 3. Color fastness to wash.

For color fastness to wash it is found very good i.e. 4-5 for all sort of liquor ratio, both in grey scale-1 and 2.

3.3 Color fastness to water

Table 5. Color fastness to water of dyed fabric.

Liquor Ratio	Staining	Change in color
1:5	3-4	4-5
1:10	3-4	4-5
1:15	3-4	4-5
1:20	3-4	4-5
1:25	3-4	4-5
1:30	3-4	4-5

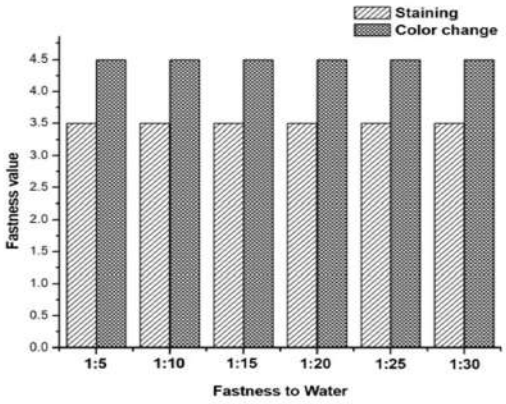


Figure 4. Color fastness to water at different liquor ratios.

From the above figure it is seen that, all have the same trend, color change scale shows very good rating, 4-5 and staining scale shows rating 3-4 for all samples.

3.4 Color fastness to perspiration

Table 6. Color fastness to perspiration in both acidic and alkaline mediums.

	Liquor Ratio	Staining	Change in color
Acid	1:5	4	4-5
	1:10	5	4-5
	1:15	4-5	4-5
	1:20	4-5	4-5
	1:25	4-5	4-5
	1:30	4	4-5
Alkali	1:5	4	4-5
	1:10	4	4-5
	1:15	3-4	4-5
	1:20	4-5	4-5
	1:25	4-5	4-5
	1:30	3-4	4-5

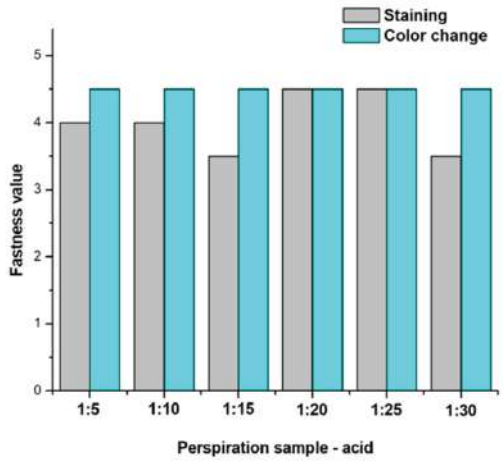


Figure 5. Color fastness to perspiration- acid.

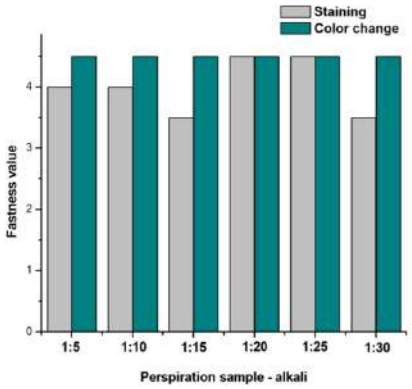


Figure 6. Color fastness to perspiration – alkali.

In case of perspiration in figure 5 for acid, both scales give overall same results that is 4-5. But for alkali staining scale presents deflection whereas color change scale shows very good values 4-5.

3.5 Color fastness to saliva

Table 7. Color fastness to saliva.

Liquor Ratio	Staining	Change in color
1:5	4-5	4-5
1:10	4-5	4-5
1:15	4-5	4-5
1:20	4-5	4-5
1:25	4-5	4-5
1:30	4-5	4-5

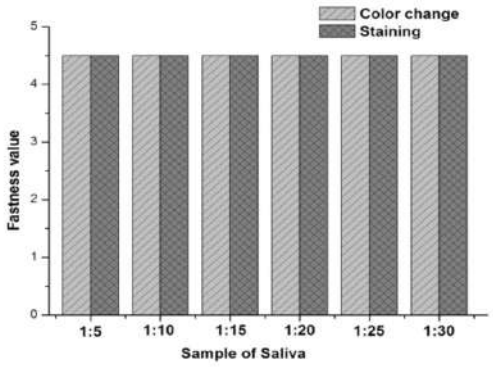


Figure 7. Color fastness to saliva.

In case of saliva both scales give very good results that are 4-5 irrespective of all liquor ratios. Considering fastness, on the other side, a good light fastness, rubbing, washing, sublimation and gas fumes of burnt, is found significant in case of disperse dyes. [6] And, for polyester fabric if fluorescent azo disperse dye is applied, then it is revealed that it increases different fastness properties [7].

3.6 Reflectance percentage

Table 8. Reflectance percentage for 450 nm.

Reflectance value(%) for 450 nm	
Liquor Ratio	**Reflectance %**
1:5	6.5
1:10	5.1
1:15	5.2
1:20	5.4
1:25	5
1:30	4.5

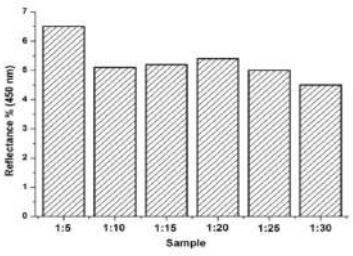


Figure 8. Reflectance percentage.

Here it is clear to express the opinion that, from figure 8, the reflectance value for 1:5 liquor ratio is maximum and from 1:10 to 1:20 samples the value is in slightly increasing trend and from 1:20 to 1:30 liquor ratio, it is in decreasing trend.

3.7 Color strength

Table 9. Color strength (K/S) of dyed fabric.

Color strength (K/S)	
Liquor Ratio	**K/S value**
1:5	2.33
1:10	1.99
1:15	1.7
1:20	1.79
1:25	1.6
1:30	1.36

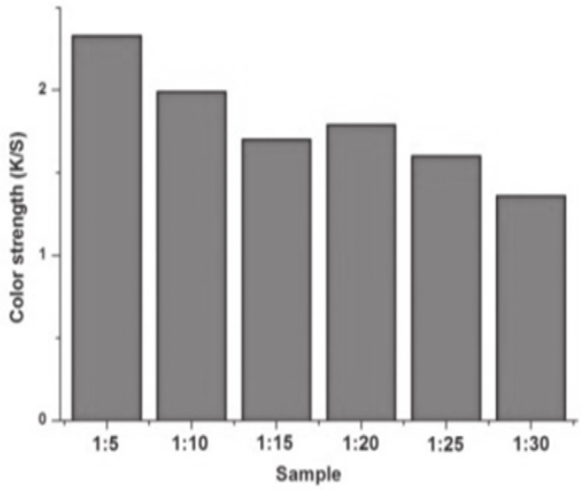


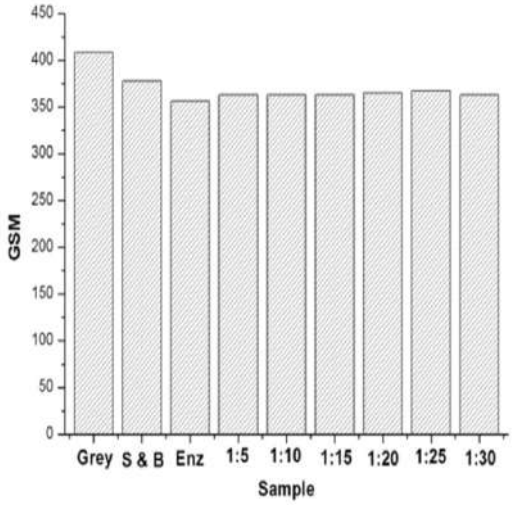
Figure 9. Color strength.

In case of color strength, it is doubtless clear that K/S values are declining with increasing liquor ratio. The reason behind this is because the concentration is more for the presence of higher amount of dyes and the strength becomes lower for milder solutions.

3.8 GSM

Table 10. GSM measurement.

Type	GSM	Deference
Grey fabric	408	-
Scouring & Bleaching	378	65
Enzyme	356	43
1:5 Dyed	363	50
1:10 Dyed	363	50
1:15 Dyed	363	50
1:20 Dyed	365	52
1:25 Dyed	367	54
1:30 Dyed	363	50



Here, S & B = Scoured-bleached and Eng = Enzyme.

Figure 10. GSM values of different fabrics.

As figure 10, the GSM is in peak for grey fabric and it is decreasing to enzyme sample for come out the fibres from the fabric for drastic process. It is interesting for the sample among 1:5 to 1:30, there is almost no change of weight but little bit increased than enzyme as dyes got stuck to the fabric in process.

4. Conclusion

Clearly, there is no significant influence of liquor ratio on perspiration and GSM. In case of rubbed sample particularly for wet test, the results are poor (2-3) comparing to the dry sample (4-5). Fastness to water, color change scale gives very good values (4-5) than staining scale. For color fastness to wash and saliva the results are very good (4-5) in both scales (grey scale-1 and 2) and same outcomes are observed for perspiration with some deflection in alkali samples. But in the cases of color strength, the values are found decreasing with the raise of liquor ratio; these are the significant results in this research ever.

Acknowledgement

Authors are eternally grateful to the management of the MICRO Fibre Ltd. for providing the opportunity to complete research successfully and also for their valuable suggestions.

REFERENCES

[1] N. Jadhav, S.R. Kulkarni, “Reproducibility of Lab to Bulk in Fabric Dyeing for Reactive Dyes on RFT Principle”, Centre for textile functions (CTF), NMIMS University, Joint collaborative projects by CTF and PSSGL ALOK , Welspun, 2014.

[2] D. A. Jadhav, R. Vora, “Detail Study of Different Dyeing Processes”, International Journal of Emerging Technology and Advanced Engineering, Volume 3, Issue 9, 2013.

[3] M F H Arzu, M.M. Rahman, “Effect of process parameters on cotton fabric dyeing with reactive dye especially on Green Color” Pakistan Textile Journal, pp. 45-47,April, 2009.

[4] A. Mutiu O, “Effects of liquor ratio, time, and concentration of dye on mercerized 100% cotton dyed with reactive or vat dyes”, Textile today, January, 2019.

[5] A. Islam, Rashaduzzaman, M. Rahman, J. Biswas, E. Khalil, “International Journal of Materials Science and Applications”, Vol. 5, No. 6, 2016, pp. 248-253,http://.doi, org: 10.11648/j.ijmsa.20160506.13, 2016

[6] J.F. Dawson, Fifty Years of Disperse Dye Rev. Prog. Coloration, Vol. 14, No. 1, pp 90-97, 1984.

[7] M. A. Satam, R. K. Raut and N.Sekar, “Fluorescent Azo Disperse Dyes from 3 - (1,3-Benzothaizol-2-yl) Naphtha-len-2-ol and Comparision with 2-Naphthol Analogs,” Dyes and Pigments, Vol. 96’ No1, pp.92-103, http://dx.-doi.org/10.1016/j.dyepig.2012.07.019, 2013