DOI 10.5281/twist.10049652#146

TWIST, 2024, Vol. 19, Issue 2, pp. 180-185

TWIST

Journal homepage: www.twistjournal.net

A Comparative Analysis of Dyeing Properties in Organic and Conventional Cotton Fabrics

Md. Masud Rana
Department of Textile Engineering, Southeast University, Dhaka, Bangladesh

Md. Riaj Uddin
Department of Textile Engineering, Southeast University, Dhaka, Bangladesh

Md. Shamim Alam*
Department of Textile Engineering, Southeast University, Dhaka, Bangladesh
[**Corresponding author*]

Abstract
This study investigates the dyeing properties of organic cotton compared to regular cotton of three different shade (Light, Medium, Dark). As we all know cotton is grown with the help of synthetic chemicals i.e. fertilizers or pesticides whereas no chemical is used in organic cotton. So, it's safe to say that dyeing characteristics between these two are not going to be same. In this paper we are going to differentiate the dyed cotton knitted fabric with reactive dye and compare dyeing properties and shade difference between conventional and organic cotton. Bezaktive reactive dye was used to complete this research work. Color fastness to wash, color fastness to rubbing, different color parameters of the dyed fabrics were also evaluated. It was discovered that, when dye concentration was the same, organic cotton exhibited superior fastness characteristics and a greater depth of shade than conventional cotton.

Keywords
Cotton, Organic cotton, Conventional cotton, Fastness, Spectrophotometer

INTRODUCTION

Cotton, also known as "white gold," has long been a vital component of human civilization and is deeply woven into both the real and symbolic fabric of our daily lives. Cotton is one of the most adored and extensively used natural fibres in the world because of its comfort and versatility, which range from the soft feel of our favourite t-shirts to the crispness of our bed linens. However, organic cotton signifies a thoughtful change in how we view sustainability and agriculture. Organic cotton, which is produced without the use of artificial fertilizers or pesticides, provides a more environmentally friendly option that enhances biodiversity, uses less water, and benefits local communities and farmers (Altenbuchner et al., 2016). The same shade of reactive dyes (Bezaktive Red, Bezaktive Yellow, and Bezaktive Blue) were used in this study for dyeing of both conventional and organic cotton fabric. Reactive dyes come into touch with a fabric molecule and create covalent bonds with it to create a strong fabric interaction. (Shen et al., 2019) In alkaline conditions, reactive dyes react with cellulose to create covalent bonds that attach the dye to the fibre. (Dong et al., 2019) The colour fastness characteristics of reactive dyes will be excellent as long as these covalent bonds remain stable under laundering conditions. The ability of a finished textile to maintain its original colour through any difficulties is known as colour fastness. (Zhao et al., 2014) The impact of reactive dye concentration (light, medium, and dark) and structure on colourfastness were examined in this study. The outcomes were contrasted to determine differences in fastness values below a standard that is applied to the textile field. Following dyeing, color fastness to rubbing and color fastness to washing were assessed. The result of this study shows that, in terms of the different fabric structures, conventional cotton and organic cotton do not significantly differ for colour fastness to dry and wet rubbing. However, each material exhibits a specific value, such as 4/5, just in case of the wash fastness aspect. It has been observed that as the depth of shade increases in wet conditions, the rubbing fastness of both organic cotton and conventional cotton decreases. However, for dry condition, it remains the same (4-5) while fabric structure does not affect (Yuruk et al., 2019).

EXPERIMENTAL METHODOLOGY

Fabric

To complete this research work scoured & bleached, conventional and organic cotton knitted fabric with160 GSM was taken from SM Knitwear Ltd Shirirchala, Bhabanipur Gazipur, Bangladesh.

Machine and Instruments

This research work involved the use of a sample dyeing machine, Spectrophotometer, dryer, pipette, scissor, beaker, electric balance, washing machine, gray scale, and rubbing fastness tester.

Dyes and Chemicals

Required dyes and chemicals that were used for this research work are (Reactive dyes: Bezaktive Red, Bezaktive Yellow, Bezaktive Blue, Soda ash, Caustic soda and Glauber Salt) and were collected from SM Knitwear Ltd. Shirirchala, Bhabanipur Gazipur, Bangladesh and other required chemicals were used.

Dyeing Procedure

First, the collected scoured and bleached fabric was divided into three batches for three different shades (light, medium, and dark), where the amount of fabric in each batch was the same. A summary of the dyeing process and ingredients is given in Table 1.

Table 1 Recipe for dyeing

Process	Chemicals	Light Shade		Medium Shade		Dark Shade	
		%	*g/L*	*%*	*g/L*	*%*	*g/L*
Dyeing	Levelling agent (DY LEVEL CN)						
	Bezaktive Red	0.2		0.5		1.0	
	Bezaktive Yellow	0.2		0.5		1.0	
	Bezaktive Blue	0.1		0.2		0.5	
	Caustic Soda		1		1		1
	Glauber Salt		20		40		50
	Soda Ash		10		16		18
Neutralization	Jingen Neutra Acid(Acetic Acid)		1		1		1
Soaping	Soaping MC		1		1		1
Softener	Mild Cationic Softener Pearl,DSS30		0.25		0.5		1
M:L		1:10		1:10		1:10	
Fabric Weight	Organic cotton	20.85 g		20.25 g		21.55 g	
Fabric Weight	Conventional cotton	19.85 g		20.2 g		21.5 g	

Evaluation of the fabric's wash-fastness

According to ISO 105-C06, sewing sample fabric with a multi-fiber fabric ensures colorfastness to wash. Color fastness to wash of the dyed fabric was tested as per the method adopted (Alam, 2016). More briefly,aA washing solution with a liquor ratio of 1:50 was made, consisting of 4 g/L detergent. For 30 minutes, the fabric was treated in a dyeing machine set to 60±20°C. After treatment, the fabric was rinsed and dried, and the color change was assessed visually in a color-matching cabinet using a greyscale under D65 light (ISO 105-C10, 2006).

Spectrophotometric Evaluation

Spectrophotometers detect the amount of light that is reflected or transmitted across the spectrum to create a visual curve that shows the color of the substrate under different conditions of lighting. (Erriu et al., 2012) Since a white surface reflects all visible light energy, its reflectance curve is linear, with a straight line representing 90% to 100% reflectance. Since black absorbs practically all light, its reflectance curve is flat and becomes close to 0%. A straight line with 50% reflectance is used to depict a mid-range gray, which is created by blending equal amounts of white and black. Other hues spike close to the most reflected region of the spectrum. (Sunil et.al., 2014). Conventional cotton fabrics were used as the standard, and the computer color matching system's built-in software was used to evaluate the depth of shade and color parameters.

Assessment of Colorfastness to rubbing

Colorfastness to rubbing was assessed using the ISO standards 105-X-12 technique. Color fastness to rubbing was evaluated as per the method described (Shamim Alam, 2017). In shortly, the size of 14cmX5cm fabric samples were placed on a rubbing fastness tester. A 5-cm-by-5-cm white cotton fabric sample was used to rub the cloth's surface both in wet and dry condition. Rubbing was performed for 10 cycles, according to the standard. After rubbing, the fabric was evaluated for any color transfer or changes in appearance. Results were compared against standardized criteria to determine the rubbing fastness rating (African Community, 2001).

RESULTS AND DISCUSSION

Shade% and structure effects on color parameters

For light shade- organic cotton vs conventional cotton

Color difference and color parameters are shown in figure 1 and described under different light sources as below:

Under D65 Light source

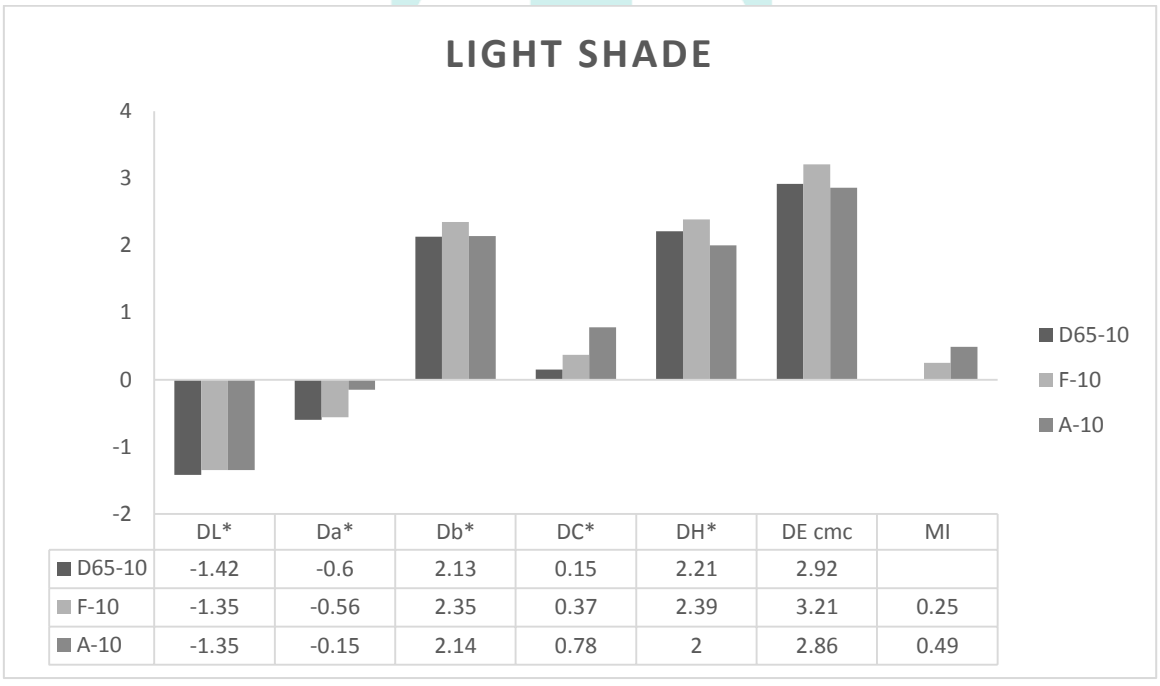
Here DL is -1.42 L that means the trial sample is Darker than the standard sample. Here Da is -0.60 G that means the trial sample is Greener or Less Red than the standard sample. Here Db is 2.13 B that means the trial sample is Yellower or Less Blue than the standard sample. Here DC is 0.15 C that means the trial sample is Brighter than the standard sample. Here DH is 2.21 G that means the standard sample has Less Hue than the standard sample. Here DE is 2.92 that means organic cotton absorbed more dye than conventional cotton.

Under F11 Light source

Here DL is -1.35 L that means the trial sample is Darker than the standard sample. Here Da is -0.56 G that means the trial sample is Greener or Less Red than the standard sample. Here Db is 2.35 B that means the trial sample is Yellower or Less Blue than the standard sample. Here DC is 0.37 C that means the trial sample is Brighter than the standard sample. Here DH is 2.39 G that means the standard sample has Less Hue than the standard sample. Same trend follows in case of DE as per D65 light source.

Under A-10 Light source

Here DL is – 1.35 L that means the trial sample is Darker than the standard sample. Here Da is 0.15 G that means the trial sample is Redder or Less Green than the standard sample. Here Db is 2.14 B that means the trial sample is Yellower or Less Blue than the standard sample. Here DC is 0.78 C that means the trial sample is Brighter than the standard sample. Here DH is 2 G that means the standard sample has Less Hue than the standard sample. Here DE is 2.86 that means organic cotton absorbed more dyes.



	DL*	Da*	Db*	DC*	DH*	DE cmc	MI
D65-10	-1.42	-0.6	2.13	0.15	2.21	2.92	
F-10	-1.35	-0.56	2.35	0.37	2.39	3.21	0.25
A-10	-1.35	-0.15	2.14	0.78	2	2.86	0.49

Fig. 1 For light shade- organic cotton vs conventional cotton

For medium shade- organic cotton vs conventional cotton

Color parameters under different light sources for medium shade are shown in figure 2 and summarized below:

Under D65 Light source

Here DL is 1.48 L that means the trial sample is Lighter than the standard sample. Here Da is 1.19 G that means the trial sample is Redder or Less Green than the standard sample. Here Db is -3.40 B that means the trial sample is Bluer or Less Yellow than the standard sample. Here DC is 0.80 C that means the trial sample is Brighter than the standard sample. Here DH is-3.51G that means the standard sample has More Hue than the standard sample.

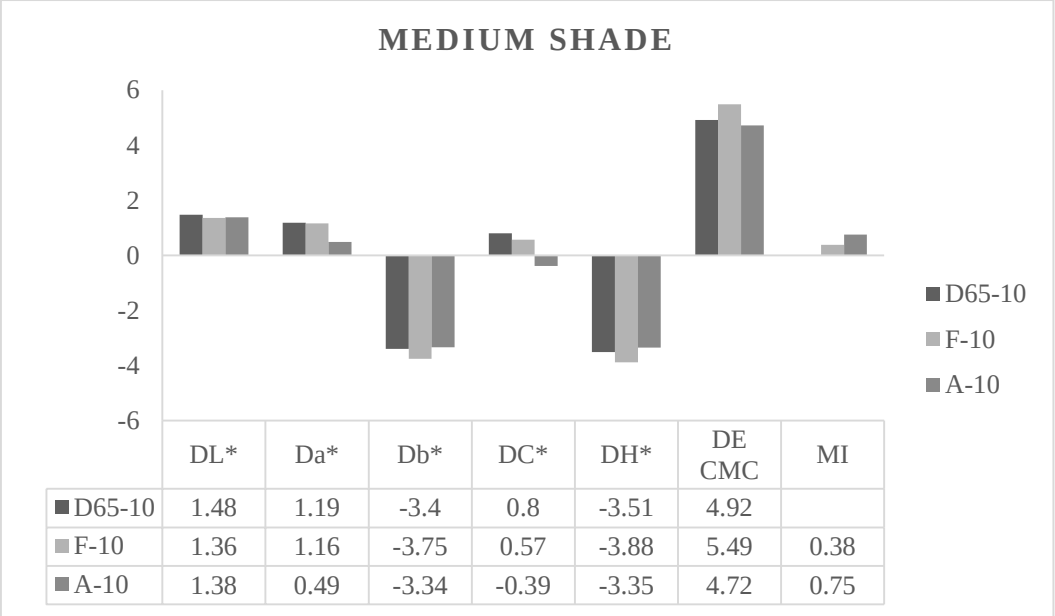
Under F11 Light source

Here DL is 1.36 L that means the trial sample is Lighter than the standard sample. Here Da is 1.16 G that means the trial sample is Redder or Less Green than the standard sample. Here Db is -3.75 B that means the trial sample is Bluer or Less Yellow than the standard sample. Here DC is 0.57 C that means the trial sample is Brighter than the standard sample. Here DH is -3.88 G that means the standard sample has More Hue than the standard sample.

Under A-10 Light source

Here DL is 1.38 L that means the trial sample is Lighter than the standard sample. Here Da is 0.49 G that means the trial sample is Redder or Less Green than the standard sample. Here Db is -3.34 B that means the trial sample is Bluer or Less Yellow than the standard sample. Here DC is -0.39 C that means the trial sample is Duller than the standard sample. Here DH is -3.35 G that means the standard sample has More Hue than the standard sample.

DE CMC value is higher than 1, although spectrometric evaluation is failed but our observation was to find out which fibre absorb more dye. In that sense, we can say, organic cotton more depth of color than conventional cotton.



	DL*	Da*	Db*	DC*	DH*	DE CMC	MI
D65-10	1.48	1.19	-3.4	0.8	-3.51	4.92	
F-10	1.36	1.16	-3.75	0.57	-3.88	5.49	0.38
A-10	1.38	0.49	-3.34	-0.39	-3.35	4.72	0.75

Fig. 2 For medium shade- organic cotton vs conventional cotton

For dark shade- organic cotton vs conventional cotton

Color parameters under different light sources for dark shade are shown in figure 3 and summarized below:

Under D65 Light source

Here DL is -0.02 L that means the trial sample is Darker than the standard sample. Here Da is -0.09 G that means the trial sample is Greener or Less Red than the standard sample. Here Db is -0.29 B that means the trial sample is Bluer or Less Yellow than the standard sample. Here DC is -0.18 C that means the trial sample is Duller than the standard sample. Here DH is -0.24 G that means the standard sample has More Hue than the standard sample. Here DE is 0.29 that means passed.

Under F11 Light source

Here DL is -0.05 L that means the trial sample is Darker than the standard sample. Here Da is -0.13 G that means the trial sample is Greener or Less Red than the standard sample. Here Db is -0.38 B that means the trial sample is Bluer or Less Yellow than the standard sample. Here DC is -0.27 C that means the trial sample is Duller than the standard sample. Here DH is -0.30 G that means the standard sample has More Hue than the standard sample. Here DE* is 0.38 that means passed.

Under A-10 Light source

Here DL is -0.05 L that means the trial sample is Darker than the standard sample. Here Da is -0.22 G that means the trial sample is more Greener or Less Red than the standard sample. Here Db is -0.30 B that means the trial sample is Bluer or Less Yellow than the standard sample. Here DC is -0.33 C that means the trial sample is Duller than the standard sample. Here DH is -0.16 G that means the standard sample has More Hue than the standard sample. Here DE* is 0.27 that means passed.

Effect of color fastness to rubbing

Table 2 presents the findings from the rubbing fastness test. It has been noted that the fabric structure has no effect on color fastness to rubbing. For varying shade percentages, there is a discernible variation in the rate of colorfastness to rubbing. This is because color is absorbed more by dark shades than by light and medium ones. As a result, color staining has a greater affinity for dark shades than for medium or light shades. For both dry and wet conditions, However, dry rubbing works better than wet rubbing. It is clear that rubbing fastness reduces with increasing depth of shade.

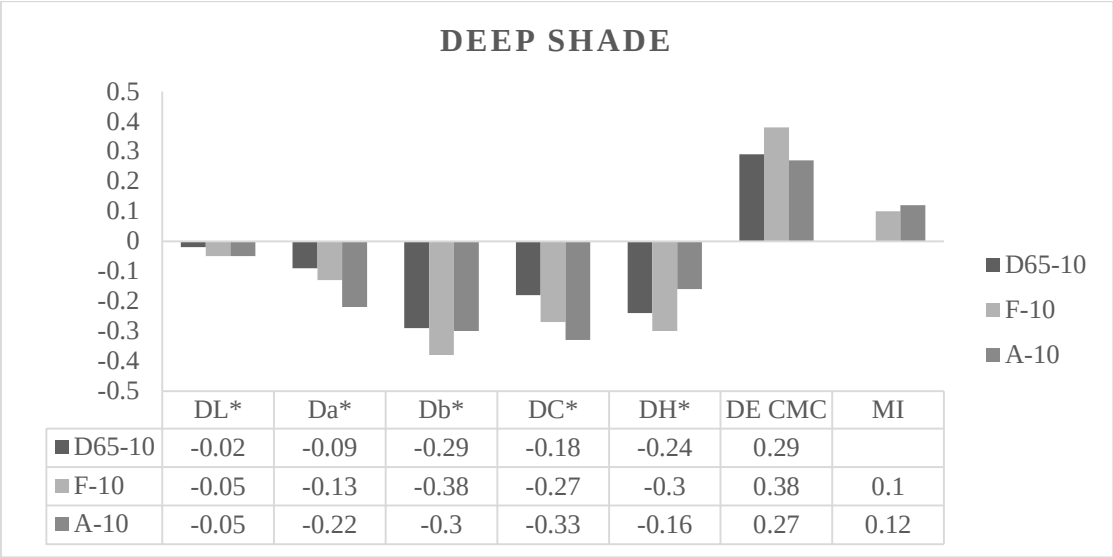


Fig. 3 For dark shade- organic cotton vs conventional cotton

Table 2 Colorfastness to Rubbing

Fabric Types	Light-Shade		Medium shade		Dark-shade	
	Dry-Rub	Wet-Rub	Dry-Rub	Wet-Rub	Dry-Rub	Wet-Rub
Organic Cotton	4-5	4-5	4-5	3-4	4-5	2-3
Conventional Cotton	4-5	4-5	4-5	3-4	4-5	2-3

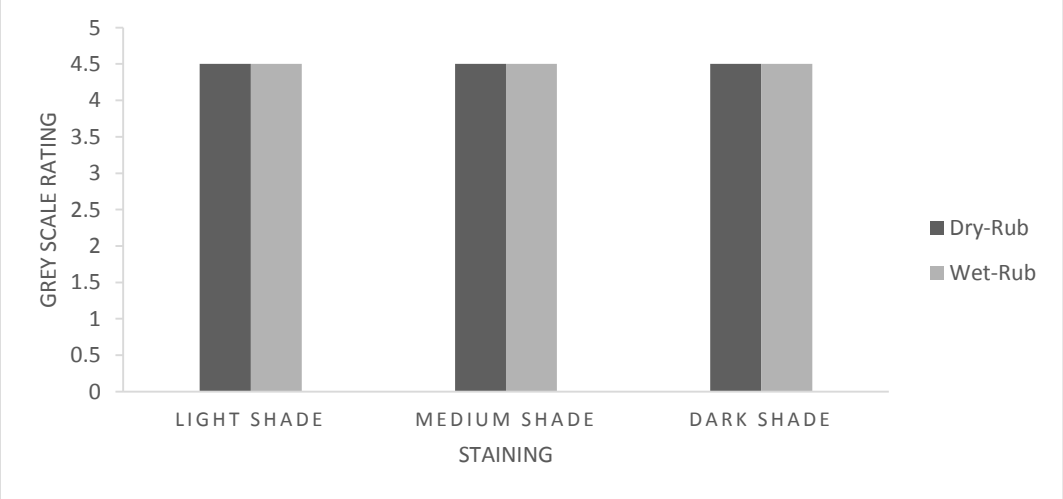


Fig. 4 Color fastness to rubbing rating

Effect of Color fastness to Wash

Table 3 shows the change in wash fastness due to shade percentage. It has been noted that shade% and fibre types have no impact on colorfastness to washing.

Table 3 Color fastness to wash

Fabric Types	Multifiber	Light-Shade	Medium shade	Dark-shade
Organic Cotton	Acetate	4-5	4-5	4-5
	Cotton	4-5	4-5	4-5
	Nylon	4-5	4-5	4-5
	Polyester	4-5	4-5	4-5
	Acrylic	4-5	4-5	4-5
	Wool	4-5	4-5	4-5
Conventional Cotton	Acetate	4-5	4-5	4-5
	Cotton	4-5	4-5	4-5
	Nylon	4-5	4-5	4-5
	Polyester	4-5	4-5	4-5
	Acrylic	4-5	4-5	4-5
	Wool	4-5	4-5	4-5

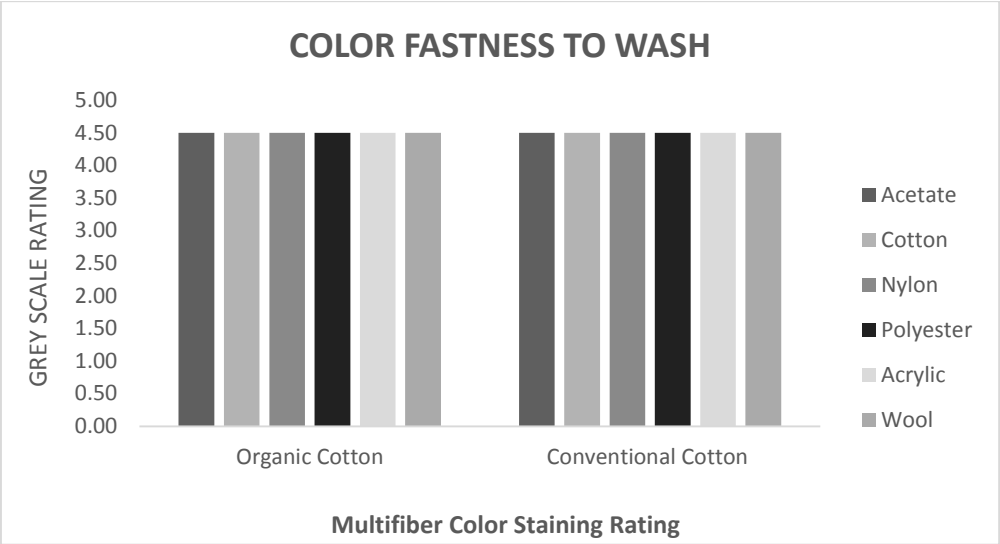


Fig. 5 Color fastness to wash rating

CONCLUSION

The purpose of the study was to assess how well organic cotton dyed in three different shades (Light, Medium, and Dark) compared to conventional cotton. Reactive dyes (Bezaktive Red, Bezaktive Yellow, and Bezaktive Blue) were chosen in order to conduct this study on organic and conventional cotton fabric. After dyeing, a notable number of changes for color parameters were found, even though the spectrometric evaluation was failed, as the DE CMC value is greater than 1 for light and medium shade, and our observation was to determine which fiber absorbs more dye. We may claim that, in this regard, organic cotton has a deeper color than conventional cotton. Beside this, DE CMC value for dark shade was less than 1. A small change was found for the color fastness properties on rubbing in wet condition. For all structures and shade percentages, wash fastness is higher while rubbing fastness is a little bit lower. On this research topic, further investigation can also be done.

REFERENCES

1. Sunil Kulkarni, (2015) A Review on Spectrophotometric Determination of Heavy Metals with emphasis on Cadmium and Nickel Determination by U.V. Spectrophotometry. (2014). Chemical Science Transactions. https://doi.org/10.7598/cst2014.636
2. African Community, E. (2001). EAS 244: Textiles — Tests for colour fastness — Colour fastness to hot pressing. www.each.int
3. Alam, M. S. (2016). Analysis of Depth of Shade on Mercerized and Unmercerized Fabric among Different Woven Fabric Structures. In Journal of Materials (Vol. 2016, pp. 1–6). https://doi.org/10.1155/2016/9739380
4. Altenbuchner, C., Larcher, M., & Vogel, S. (2016). The impact of organic cotton cultivation on the livelihood of smallholder farmers in Meatu district, Tanzania. Renewable Agriculture and Food Systems, 31(1), 22–36. https://doi.org/10.1017/S1742170514000416
5. Dong, X., Gu, Z., Hang, C., Ke, G., Jiang, L., & He, J. (2019). Study on the salt-free low-alkaline reactive cotton dyeing in high concentration of ethanol in volume. Journal of Cleaner Production, 226, 316–323. https://doi.org/10.1016/j.jclepro.2019.04.006
6. Erriu, M., Genta, G., Tuveri, E., Orr, G., Barbato, G., & Levi, R. (2012). Microtiter spectrophotometric biofilm production assay analyzed with metrological methods and uncertainty evaluation. Measurement: Journal of the International Measurement Confederation, 45(5), 1083–1088. https://doi.org/10.1016/j.measurement.2012.01.033
7. ISO 105-C10. (2006). www.iso.org
8. Shamim Alam, M. (2017). Aloe Vera Skin: A New Bio Material for the Coloration of Silk Fabric and Evaluation of Fastness and Color Strength. Advancements in Materials, 1(1), 14. https://doi.org/10.31058/j.am.2017.11002
9. Shen, C., Pan, Y., Wu, D., Liu, Y., Ma, C., Li, F., Ma, H., & Zhang, Y. (2019). A crosslinking-induced precipitation process for the simultaneous removal of poly(vinyl alcohol) and reactive dye: The importance of covalent bond forming and magnesium coagulation. Chemical Engineering Journal, 374, 904–913. https://doi.org/10.1016/j.cej.2019.05.203
10. Yuruk, N., Mangut, M., & Becerir, B. (2019). Assessing Color Properties of Reactive Dyed Cotton Fabrics after Different Sequential Fastness Test Procedures. Fibers and Polymers, 20(7), 1443–1454. https://doi.org/10.1007/s12221-019-8593-9
11. Zhao, Q., Feng, H., & Wang, L. (2014). Dyeing properties and color fastness of cellulase-treated flax fabric with extractives from chestnut shell. Journal of Cleaner Production, 80, 197–203. https://doi.org/10.1016/j.jclepro.2014.05.069