FASTNESS PROPERTIES IMPROVEMENT OF FLUORESCENT PIGMENTS

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Abstract: *The resistance of the material to a change of its color characteristics during exposure to sunlight, rubbing and washing as domestic and laundry and other various ways are referred to as color fastness of dyes or pigments. In this research, 100% cotton and blended fabrics were dyed with fluorescent pigments i.e. Shining Flu Pink-F17 and Papillion Orange-FGRN in exhaust dyeing method. The improvement of color fastness properties, i.e. color fastness to washing, rubbing, perspiration and light were observed with the treatment of using antioxidants and UV-absorbers. There were eight samples of dyed fabrics (Four samples of 100% cotton knit fabric and four samples of 60/40 cotton-polyester blended fabrics) treated with 1% (v/v) of antioxidants i.e. Gallic acid, L-Ascorbic acid and UV absorbers i.e. 2-hydroxy-4 methoxy-benzophenone, 4-4 dimethoxy-benzophenone respectively. The treatment of antioxidant L-Ascorbic acid and UV absorber 4-4 dimethoxy-benzophenone provides satisfactory improvement of fastness properties than other antioxidants and UV absorbers. The results were mainly interpreted in terms of color strength, visual assessment of evenness and fastness ratings.*

Keywords: *cotton fabric, fluorescent pigments, color fastness, adsorption, color strength, dyeing blended knit fabric.*

1 INTRODUCTION

The natural grey textile fabric is colored to make it more attractive and comfortable to the wearers by dyeing. So, textile dyeing is one of the most important coloration steps of any textiles materials. Different types of textile fabric i.e. 100% cotton and cotton-polyester blended fabric were dyed by using different types of natural dyes like Turmeric (Curcuma longa L.), Hibiscus (Tea), Avocado etc. and different synthetic dyes [1]. Different scientists and researchers are trying to develop this dyeing process with increasing different properties of the dyed fabric. Besides dissimilar types of pigments are also using in dyeing textile fabric. The pigment dyeing in the exhaust method is generally unpopular due to the unevenness or unlevelled problem. Moreover, many pigment manufacturers standardized the process for exhaust dyeing which are not free from the problem of fastness properties as well [2]. However, pigment has no direct substantivity towards the cotton as pigments contain an anionic dispersing agent and cotton has partially anionic in nature. To create the cationic charge on cotton by using cationizing agents [3], substantivity of cotton and pigments to each other can be developed [4]. Fluorescent pigment is one of them which is now used in dyeing textile fabrics. Fluorescent pigments are such kinds of pigments that can sharpen the fabric's color by emitting more light than the conventional pigments. For producing brighter color, these pigments are chosen by the manufacturer rapidly nowadays. Evenmore, pigments are much more used in synthetic fabric dyeing than cotton due to its poor color fastness as well as light, washing, rubbing, perspiration. On the other side, Antioxidants and UV absorbers are generally applied to dyed fabrics due to resist the fading and bleeding of color [5].

Some textile substrates such as cotton, polyester and nylon fabrics were dyed using fluorescent and non-fluorescent pigments followed by color fastness properties evaluation of the dyed materials [6]. In exhaust methods, cotton, polyester and nylon were dyed with fluorescent and non-fluorescent pigments and found that both dyed fabrics showed poor pigment build-up and levelness [7]. So, fluorescent pigments are used for dyeing the cotton-polyester blended fabric under different conditions [8]. Moreover, Fluorescence dyes involve the absorption of ultraviolet (UV) or visible light and emission of light at higher wavelengths. These dyes are clarified as compounds that both absorb and emit strongly in the visible region, and which have concern with their potential for application to their intense fluorescence properties [9]. Normally, the fastness properties of the fluorescent pigment are not so good. So, the levelness of the fluorescent pigment was improved by the use of cationization by using different levelling agents and others supporting auxiliaries.

Moreover, the performance of two conventional UV absorbers, benzophenone and its derivative 2,4 dihydroxybenzophenone was studied in terms of ultraviolet protection factors as well as color fastness, tensile strength, handle etc. [10]. The effects of UV finish with 2,4 dihydroxybenzophenone were found to be more pronounced compared to that with benzophenone. Cotton finished with benzophenone increased the Ultraviolet protection factor (UPF) as well as dyed cotton. Azobenzophenone has excellent UV protection with a lower yellowish effect [11]. The light fastness property of the dyed samples before and after the treatment using UV absorber was tested as per international standards. The results show that for all light, medium and dark shades the dye exhaustion and fixation percentages were very good. Before applying UV absorbers, color fastness to light was poor but after application improved noticeably [12]. Using the antioxidants and UV absorbers for the development of light fastness properties, the cotton fabrics have been dyed with C.I Reactive Yellow-84, C.I Reactive red-22 and C.I Reactive Blue-19 dyes. The antioxidants such as GA, vitamin C and caffeic acid, and the UV absorbers such as 2-hydroxybenzophenone and phenyl salicylate have been applied on reactive dyed cotton fabric by exhaust method. It has been established that the use of UV absorbers or antioxidants improves the light fastness of dyed fabrics. To improve the dyeing fastness properties of the naphthalimide fluorescent dye poly (amidoamine) dendrimer was used [13] and furthermore, fluorescent dye also was selected as a colorant in regenerated cellulose fabric [14] binder-free cotton fabric printing [15-16] and denim dyeing [17].

In the UV-visible spectral analysis, Cibatex UPF has been found to be a suitable agent for rendering adequate UV protection to the cotton/jute fabrics. At present time dyeing and finishing with Cibacron Red FAL and Cibatex UPF provides higher UV protection. The treatment with TiO_2 of Cotton/jute fabrics also provides satisfactory protection against UV rays and radiation [18]. Ultraviolet absorbers are organic/inorganic colorless compounds with strong absorption in the ultraviolet wavelength range of 290 nm-360 nm and block the ultraviolet radiation from reaching the human skin when incorporated in the fabrics [19]. In the case of synthetic fibers, polyester and polyamide fibers have higher absorption in the UV-B region and Acrylic has lower absorption capacity as compared with others. In the bleaching process, some natural UV absorbers reduce the UV absorption capacity of natural fibers [20]. A group of authors studied and proved that the color fastness performance and result of using UV absorbers and antioxidants with different dyes on cotton improved significantly. So, UV absorbers and antioxidants are used to prevent the photo-fading and color bleeding on cotton dyed with fluorescent pigments in exhaust dyeing technique [21]. Few more researchers also worked on the chemistry and reactive species in photo-fading where most attention has been given to singlet oxygen ($^1O_2$) which can be formed due to the demolition of excited states of dyes by the triplet state of oxygen. Singlet oxygen is very reactive toward dyes and pigments which is the reason for fading of color [22].

The main objective of this work was to improve of color fastness properties of the fluorescent pigments by using two UV absorbers (2-H4-MB and 4-4DB) and two Antioxidants (GA and LAA) on 100% cotton and cotton/polyester blended fabric. LAA, GA, 2-H4-MB, 4-4DB were selected as antioxidants and UV absorbers because of its availability in market and it is quite less costly than other staff and same fact works for selecting the fluorescent pigments (SFP-F17 and PO-FGRN) which are used in production widely. To conduct the research, 100% cotton and blended fabrics were dyed with fluorescent pigments (SFP-F17 and PO-FGRN) using exhaust dyeing method for the improvement of color fastness properties, i.e. color fastness to washing, rubbing, perspiration and light with the treatment of using antioxidants and UV-absorbers. There were eight samples of dyed fabrics (Four samples of 100% cotton knit fabric and four samples of 60/40 cotton-polyester blended fabrics) treated with 1% (v/v) of antioxidants (GA and LAA) and UV absorbers (2-H4-MB and 4-4DB) respectively.

2 MATERIALS AND METHODS

2.1 Materials

To complete the study, two categories of well scoured and bleached fabrics were selected i.e., 100% cotton and 60/40 cotton-polyester blended knit fabrics with gram per square meter (GSM)=160, yarn count = 30 Ne and stitch length=2.72mm. The fabric was collected from the local market in Bangladesh. Commercially used direct fluorescent dyes namely Shining Flu Pink-F17 and dispersed fluorescent dyes namely Papillion Orange FGRN were purchased from the manufacturer of Kyung-In Synthetic Corporation (KISCO), Seoul, Korea. The cationizing agent Acramin Prefix K (CAS number: 68131-73-7) was collected from the Netherlands, the wetting agent (Brand name WETEX HD-82, CAS number:160875-66-1) was sourced from Zhuhai Huada Wholewin Advanced Materials company Limited, No.233 Langwan Road, Zhuhai, the sequestering agent (Trade Name: SINQUEST CS 006, CAS number: 2809-21-4) was purchased from Yantai Yuanming Textile Tech Co. Ltd., and the stabilizer (Trade Name: Clarite CBB, CAS Number: 68-04-2) was collected from the Huntsman, Bangladesh.

The antioxidants (GA, LAA) and the UV absorbers (2-H4-MB, 4-4DB) were used for treating the cotton and cotton/polyester blended fabric before checking the color fastness properties. These were collected from commercial sources (Acros organics, Sigma-Aldrich, Germany), and The CAS number of LAA is 50.81.7; GA is 149.91.7; 2-H4-MB is 117-99-7 and for 4-4DB is 90-96-0.

2.2 Methods

2.2.1 Scouring and bleaching pretreatment process of the sample

For the scouring and bleaching process, initially, a recipe was prepared by mixing H_2O_2: 5 g/L, NaOH: 4 g/L, wetting agent: 1 g/L, detergent: 1 g/L, sequestering Agent:1 g/L, stabilizer: 2 g/L and scouring and bleaching were done following Figure 1.

2.2.2 Cationization process

Cationization process is depicted at Figure 2(a) where the cationizing agent (Acramin Prefix-K) was applied at 90 ºC for 10 minutes with the concentration of 5% on-weight-fabric (OWF) while levelling agents (equivalent mixture of oxinol A-24 or oxinol 894 or oxinol LLS) were taken 1 g/L. The effect of the above process on color depth and levelness was gauged by subsequent dyeing with pigments.

2.2.3 Dyeing procedure and sample preparation

The cationized fabrics were dyed with the different pigments; i.e. (SFP-F17) for 100% cotton and (PO-FGRN) for polyester part of 60/40 cotton-polyester blended fabrics by using 1 g/L levelling agents. Both fabrics (100% cotton and 60/40 cotton-polyester blended) were dyed as per the below mentioned recipe. Polyester part was dyed at first according to Figure 2(b) where the sample weight: 10 g, fluorescent pigments (PO-FGRN): 2% OWF, dispersing agents: 1 g/L, temperature:135 ºC, time: 30 minutes, pH: 4.0, molecular and liquor ratio 1:10. Reduction clearing was done as per practically available using methods following that fabrics were cationized by the commercially available cationizer, and dyeing of cotton part was performed as recipe of sample weight: 10 g, fluorescent pigments (SFP-F17): 2% OWF, binder: 5 g/L, levelling agents: 1 g/L, temperature: 80 ºC, time: 45 minutes at molecular and liquor ratio 1:10. The identical recipe was followed to dye the 100% cotton fabric that was used in cotton part dyeing sequence of 60/40 cotton-polyester blended fabric which has been mentioned in Figure 2(c). After dyeing, both fabrics were washed, dried and cured properly following the standard procedure.

2.2.4 Application of UV absorbers and antioxidants

The antioxidants (LAA and GA) and the UV absorbers (2-H4-MB and 4-4 DB) each of 1 g/L concentration were applied to the dyed cotton and blended fabric in a solution at 70 ºC, with 30 minutes stirring that is mentioned in Figure 2(d). The antioxidant LAA dissolves in water but GA and other UV absorbers do not readily dissolve in water.So, methanol was used to dissolve as the recipe of LAA: 1 g/L, GA: 1 g/L (with the mixture of water/methanol at 9/1 v/v), 2-H4-MB: 1 g/L (with the mixture of water/methanol at 9/1 v/v), 4-4DB: 1 g/L (with the mixture of water/methanol at 9/1 v/v) at temperature of 70 ºC for the time of 30 minutes to produce aqueous solution for soaking of fabrics. After treatment, the samples were washed and dried.

2.2.5 Color fastness properties test

Color fastness test properties of all dyed specimens were carried out in accordance with the test methods provided by the ISO Standard where DW (Diacetate-Wool) type multi-fiber fabric was used as it is recommended by ISO. Eventually, the methods were chosen for color fastness to washing ISO 105-C06 B_2S Standard, color fastness to water ISO 105-E01 Standard, color fastness to perspiration ISO 105-E04 Standard, color fastness to rubbing ISO 105-X12 (dry and wet) Standard and color fastness to light ISO 105-B02:2013 Standard.

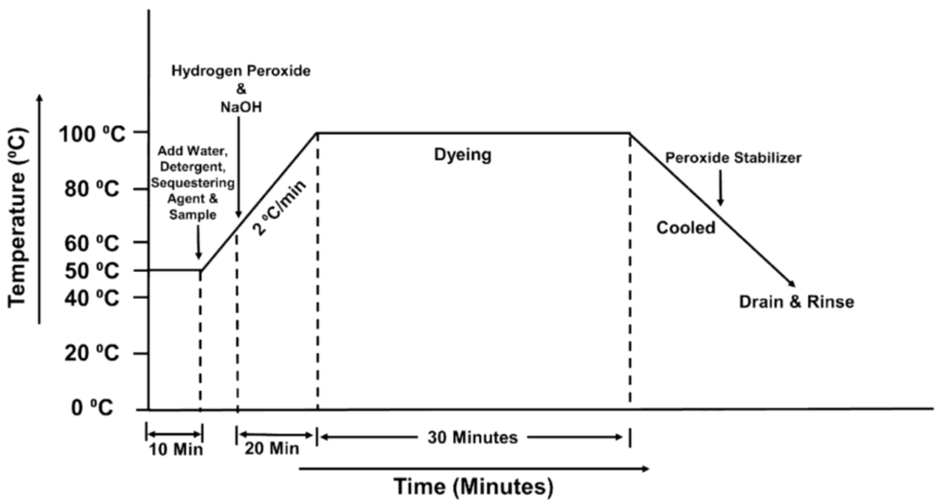


Figure 1 Process curve of scouring and bleaching in same bath

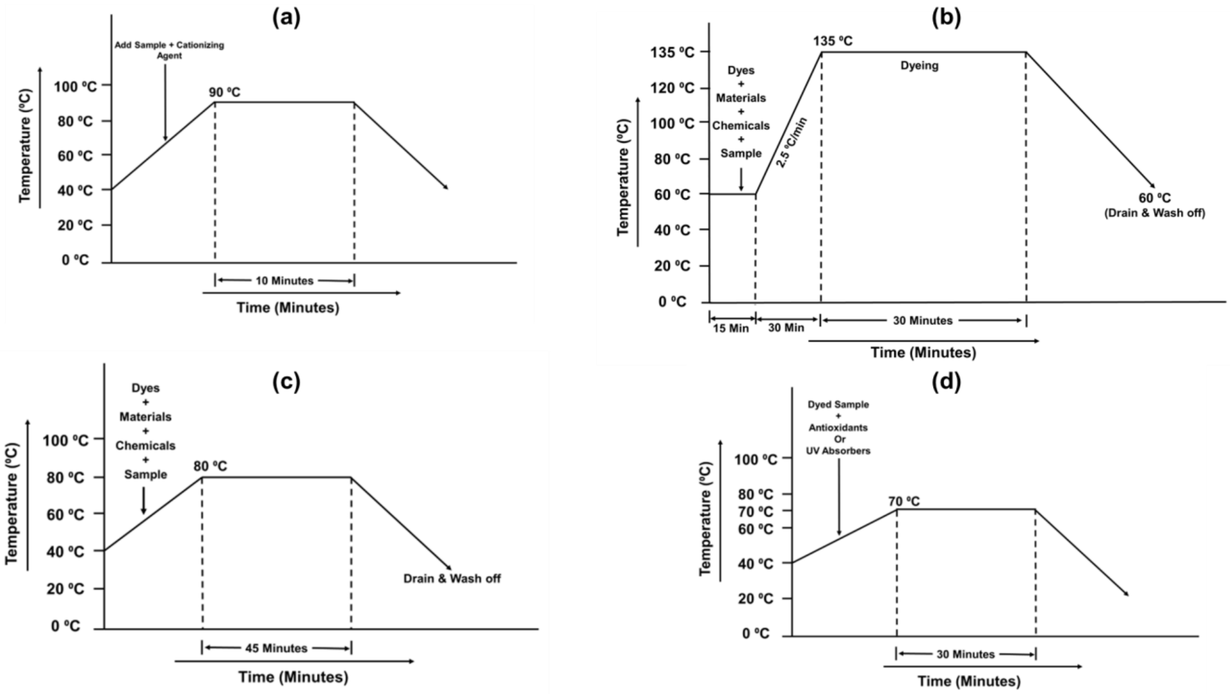


Figure 2 Process Sequences of (a) cationization process (b) polyester dyeing (c) cotton dyeing (d) antioxidants and UV absorbers application

The color strength and the dye absorption of the dyed samples were measured by K/S value by using color measuring instrument (spectrophotometer) which determines the K/S value of a given fabric by using the following formula:

$$\text{Color strength (K/S)} = \frac{(1-R)2}{2R}, \quad (1)$$

where R = Reflectance percentage, K = Absorption and S = Scattering of dyes.

3 RESULTS AND DISCUSSION

3.1 Color fastness to washing of the 100% cotton fabric and cotton/polyester blended fabric

After washing, the color-changing of 100% cotton (Table 1) without chemical treatment showed the rating 3-4 and 4-4DB showed 4-5 grading (in Greyscale), however LAA, GA and 2-H4-MB treated sample was showing slightly more change of color as grading 4 in greyscale rating. On the other hand, the color staining result of the treated sample was improved significantly than the untreated/ original sample of fabrics. Between the two antioxidants, LAA treated fabric showed comparatively better improvement of color fastness than other antioxidants (GA). And for UV absorbers, both types of treated fabrics showed similar improvement of color fastness as compared with the original sample of fabrics; a similarly improved fastness also was observed by Z. Latif *et.al.* in their research [11].

On the other hand, the color changing of the cotton/polyester blended untreated sample (Table 2) after washing was 4 and same improved fastness (4-5) was found after treatment with all the antioxidants and UV absorbers. In case of the color staining result of the treated sample was improved equally than the untreated/ original sample of fabrics.

Table 1 Color fastness to washing of 100% cotton fabric

	Multi-fiber fabric (DW)	*Results*				
		Before chemical treatment	*After chemical treatment*			
		Original Sample	*LAA*	*GA*	*2-H4-MB*	*4-4 DB*
Color Change	------	3-4	4	4	4	4-5
Color Staining	Acetate	3-4	4-5	4-5	4-5	4-5
	Cotton	4	4-5	4	4-5	4-5
	Nylon	2	4-5	4	4	4
	Polyester	3-4	4-5	4-5	4-5	4-5
	Acrylic	4-5	4-5	4	4	4
	Wool	3	4-5	4-5	4-5	4-5

Table 2 Color fastness to washing of cotton/polyester blended fabric

	Multi-fiber fabric (DW)	*Results*				
		Before chemical treatment	*After chemical treatment*			
		Original Sample	*LAA*	*GA*	*2-H4-MB*	*4-4 DB*
Color Change	------	4	4-5	4-5	4-5	4-5
Color Staining	Acetate	3-4	4-5	4-5	4-5	4-5
	Cotton	4	4-5	4-5	4-5	4-5
	Nylon	3	4-5	4-5	4-5	4-5
	Polyester	3-4	4-5	4-5	4-5	4-5
	Acrylic	4	4-5	4-5	4-5	4-5
	Wool	3	4-5	4-5	4-5	4-5

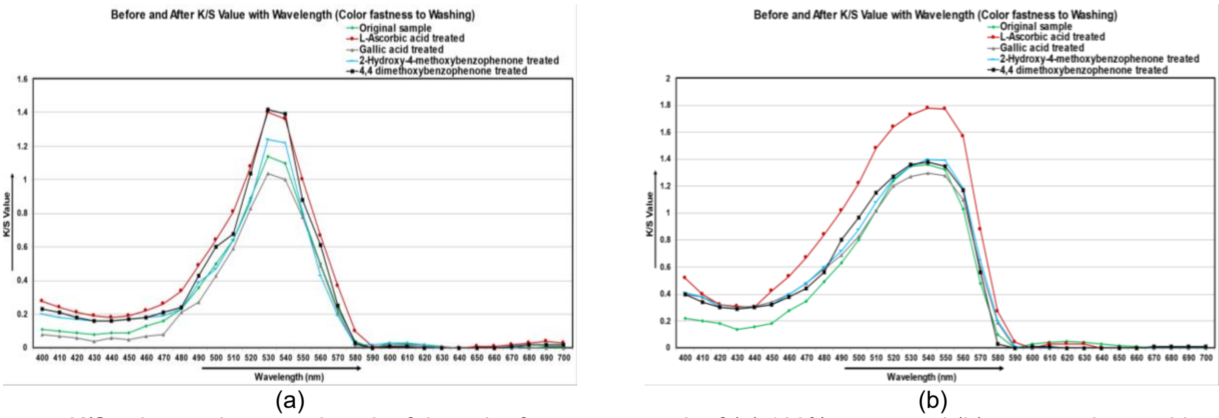


Figure 3 K/S value against wavelength of the color fastness to wash of (a) 100% cotton and (b) cotton-polyester blended fabric

Figure 3(a) explores that after washing process of 100% cotton fabric, the K/S value of treated sample like LAA, 4-4DB and 2-H4-MB was quite better than the original untreated dyed sample where K/S Value of the GA treated sample was a little bit less. On the other part, in cotton/polyester blended fabric (Figure 3(b)), all the treated samples are showed improved color strength than the original sample and among all the antioxidants and UV absorbers, GA's performance was a bit lower and LAA showed better color strength than others.

3.2 Color fastness to water of the 100% cotton fabric and cotton/polyester blended fabric

Table 3 Color fastness to water of 100% cotton fabric

	Multi-fiber fabric (DW)	Results				
		Before chemical treatment	After chemical treatment			
		Original Sample	LAA	GA	2-H4-MB	4-4 DB
Color Change	------	3-4	4-5	4-5	4	4-5
Color Staining	Acetate	3	4	4-5	4-5	4-5
	Cotton	3-4	4-5	4	4-5	4-5
	Nylon	3	4	4	4	4-5
	Polyester	3-4	4-5	4-5	4-5	4-5
	Acrylic	2-3	4-5	4	4	4
	Wool	2-3	4-5	4-5	4-5	4-5

Table 4 Color fastness to water of cotton/polyester blended fabric

	Multi-fiber fabric (DW)	Results				
		Before chemical treatment	After chemical treatment			
		Original Sample	LAA	GA	2-H4-MB	4-4 DB
Color Change	------	4	4	4	4	4-5
Color Staining	Acetate	4-5	4-5	4-5	4	4-5
	Cotton	4-5	4-5	4-5	4	4-5
	Nylon	4	4	4	4	4-5
	Polyester	4-5	4-5	4	4	4-5
	Acrylic	3-4	4	4-5	4-5	4
	Wool	4	4-5	4-5	4-5	4-5

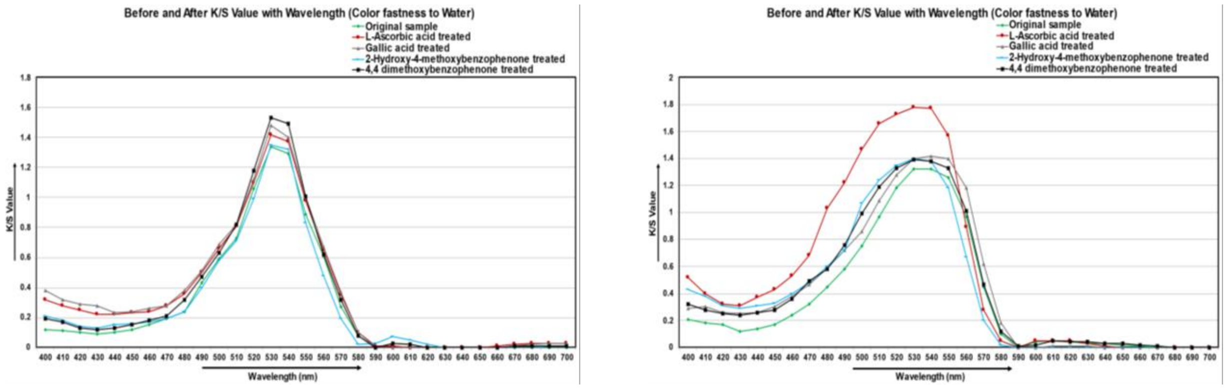
In the case of color fastness to water for 100% cotton (Table 3), changing of without chemical treated sample exhibited rating 3-4, and 4-4DB, LAA and GA treated samples rated similar 4-5 grading in greyscale. But 2-H4-MB treated sample showed a slightly changed color as grade 4. On the contrary, the color staining result was improved significantly than the untreated sample. Between two antioxidants, LAA treated sample had minimal improved color fastness than GA and 4-4DB performed better color fastness to water than 2-H4-MB sample. More or less alike performance of other antioxidants and UV absorbers were observed in P. Thiagarajan and G. Nalankilli's findings [12].

Conversely, color changing tendency in case of color fastness to water of cotton/polyester blend (Table 4) was nearly same (4) for all treated and untreated samples except 4-4DB sample (4-5). The color staining properties were quite similar to the 100% cotton samples. There weas no significant deviation in performance of both antioxidants and UV absorbers.

Color fastness to water test of 100% cotton fabric (Figure 4(a)) revealed the K/S value of treated sample like LAA, 4-4-DB and GA which were enhanced than 2-H4-MB and untreated or original dyed sample. Among the treated samples, the K/S Value of 4, 4-DB treated samples possessed higher than the others samples. Besides, LAA evidenced the highest color strength than other treated samples where 2-H4-MB and GA treated samples' k/s values were moderate to untreated samples in cotton/polyester blended fabrics (Figure 4(b)).

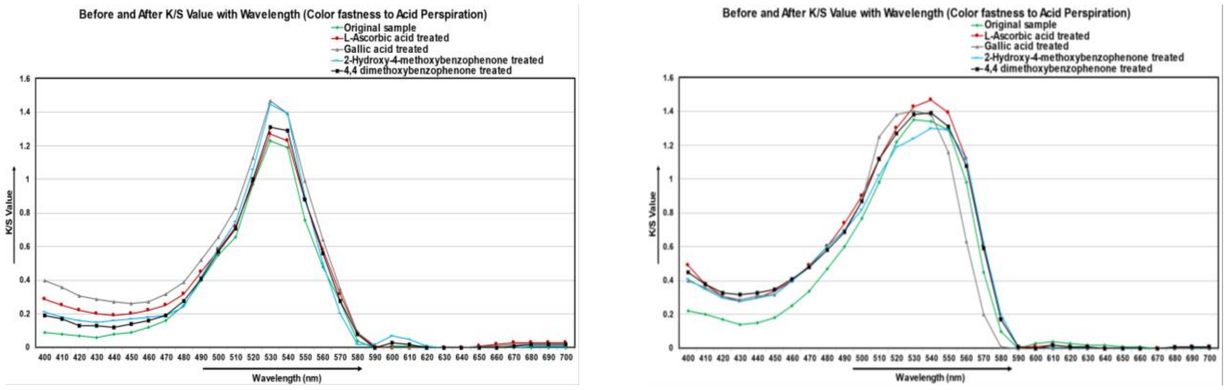
3.3 Color fastness to acid perspiration of the 100% cotton fabric and cotton/polyester blended fabric

In color fastness to acid perspiration of 100% cotton fabric (Table 5), untreated sample color changing value was 3-4 where 4-4DB, LAA showed an improved grading as 4-5 but GA and 2-H4-MB treated samples showed slightly more color change at 4 in greyscale. In case of color staining result, a significant development was found after chemical treatment which is 4-4DB treated sample exhibited the best fastness rating (4-5) of other chemicals.



(a) (b)

Figure 4 K/S value against wavelength of the color fastness to water of (a) 100% cotton and (b) cotton-polyester blended fabric



(a) (b)

Figure 5 K/S value against wavelength of the color fastness to acid perspiration of (a) 100% cotton and (b) cotton-polyester blended fabric

Table 5 Color fastness to acid perspiration of 100% cotton fabric

	Multi-fiber fabric (DW)	***Results***				
		Before chemical treatment	***After chemical treatment***			
		Original Sample	***LAA***	***GA***	***2-H4-MB***	***4-4 DB***
Color Change	------	3-4	4-5	4	4	4-5
Color Staining	Acetate	3	4-5	4-5	4-5	4-5
	Cotton	3-4	4-5	4	4	4-5
	Nylon	2-3	4	3-4	3-4	4-5
	Polyester	3-4	4-5	4	4-5	4-5
	Acrylic	2	4	4	4	4-5
	Wool	2-3	4-5	4-5	4-5	4-5

Table 6 Color fastness to acid perspiration of cotton/polyester fabric

	Multi-fiber fabric (DW)	***Results***				
		Before chemical treatment	***After chemical treatment***			
		Original Sample	***LAA***	***GA***	***2-H4-MsB***	***4-4 DB***
Color Change	------	4	4-5	4-5	4-5	4-5
Color Staining	Acetate	4-5	4-5	4-5	4-5	4-5
	Cotton	4-5	4-5	4-5	4-5	4-5
	Nylon	4	4-5	4-5	4-5	4-5
	Polyester	4-5	4-5	4-5	4	4-5
	Acrylic	4	4	4	4	4
	Wool	4	4-5	4-5	4-5	4-5

But when it came with the cotton/polyester blended fabric (Table 6), untreated sample showed more color change and color staining grading than 100% cotton fabric. Treated samples with antioxidants and UV absorbers were slightly upgraded (4-5) than untreated samples.

Figure 5(a) exposed the color fastness to Acid perspiration of 100% cotton fabric where the K/S value of treated sample like LAA, 4, 4-DB was slightly higher than untreated or original dyed sample and among the treated samples, the K/S Value of 2-H4-MB, GA treated samples were far elevated than the others samples. In the case of cotton/polyester blended samples (Figure 5.b), the K/S value of treated samples of LAA, GA, 4-4DB was exposed to slightly better results than original and 2-H4-MB treated samples.

3.4 Color fastness to alkali perspiration of the 100% cotton fabric and cotton/polyester blended fabric

Color fastness to alkali perspiration of 100% cotton fabric (Table 7) was improved suggestively after treated with antioxidants and UV absorbers. Color changing tendency of LAA, GA, 2-H4-MB was same (grade 4) where 4-4DB was a little higher to 4-5. Best color staining was observed for 4-4DB treated samples, even UV absorbers color staining grade was better than antioxidants.

Table 7 Color fastness to alkali perspiration of 100% cotton fabric

	Multi-fiber fabric (DW)	Results				
		Before chemical treatment	After chemical treatment			
		Original Sample	LAA	GA	2-H4-MB	4-4 DB
Color Change	------	3-4	4	4	4	4-5
Color Staining	Acetate	3-4	4	4	4-5	4-5
	Cotton	3-4	4	3-4	4	4-5
	Nylon	2	4	4	4-5	4-5
	Polyester	3-4	4-5	4	4-5	4-5
	Acrylic	2-3	4	4	4-5	4-5
	Wool	2-3	4-5	4	4-5	4-5

Table 8 Color fastness to alkali perspiration of cotton/polyester blended fabric

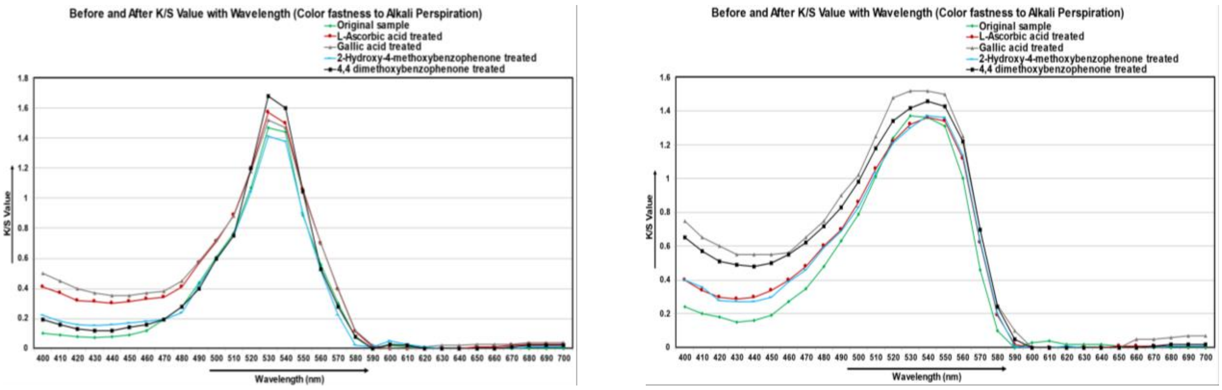
	Multi-fiber fabric (DW)	Results				
		Before chemical treatment	After chemical treatment			
		Original Sample	LAA	GA	2-H4-MB	4-4 DB
Color Change	------	4	4	4-5	4-5	4-5
Color Staining	Acetate	4-5	4-5	4	4	4
	Cotton	4-5	4-5	4	4-5	4
	Nylon	4	4-5	4	4-5	4-5
	Polyester	4-5	4-5	4-5	4-5	4-5
	Acrylic	4-5	4-5	4-5	4-5	4-5
	Wool	4-5	4-5	4-5	4-5	4-5

On the contrary, in cotton/polyester blended fabric (Table 8), no noticeable color changing and color staining variation was observed among treated and untreated samples. Compare to 100% cotton fabric findings, the fastness properties of original, LAA and GA teated samples of cotton/polyester blended fabrics were far better than 100% cotton fabric.

LAA and 4-4DB treated samples exhibited higher K/S value than other treated samples in color fastness to Alkali perspiration of 100% cotton fabric (Figure 6(a)). On the other hand, the color strength of LAA, GA and 4-4DB was improved than 2-H4-MB treated and untreated original sample (Figure 6(b)) of cotton/polyester blended fabrics.

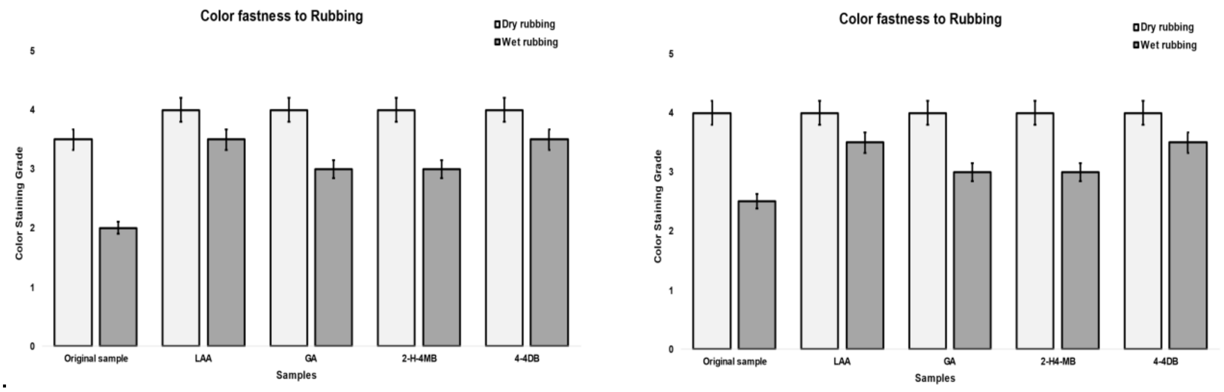
3.5 Color fastness to rubbing of the 100% cotton fabric and cotton/polyester blended fabric

Color fastness to dry and wet rubbing of both 100% cotton and cotton/polyester blended fabric are mostly same except for the 100% cotton original sample (Figure 7(a)) which rubbing grading is a little bit less than cotton/polyester blended fabric (Figure 7(b)). Though the dry rubbing grade (4) is similar for both the fabric types, the wet rubbing of GA and 2-H4-MB (grade 3) are a little poor than LAA and 4-4DB (grade 3-4). Error bars express the confidence level of each grading where error percentage is set at 5% which eventually leads to 95% confidence level.



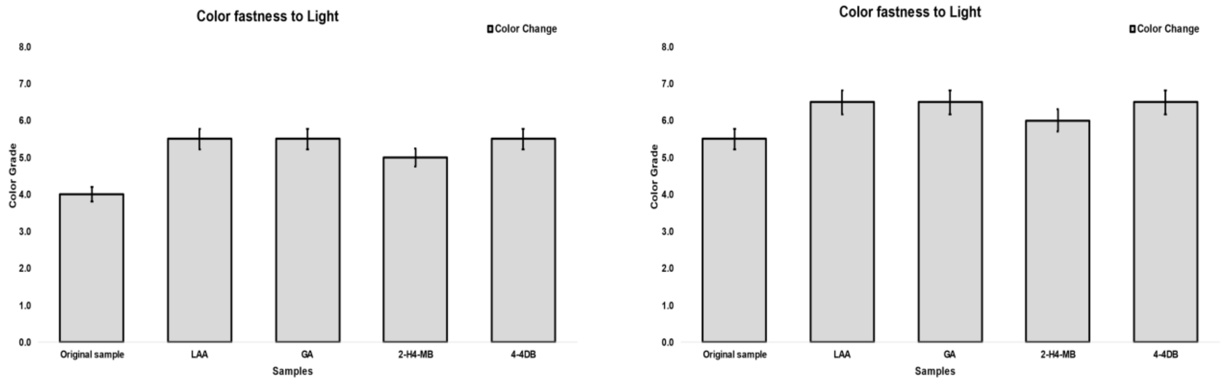
(a) (b)

Figure 6 K/S value against wavelength of the color fastness to alkali perspiration of (a) 100% cotton and (b) cotton-polyester blended fabric



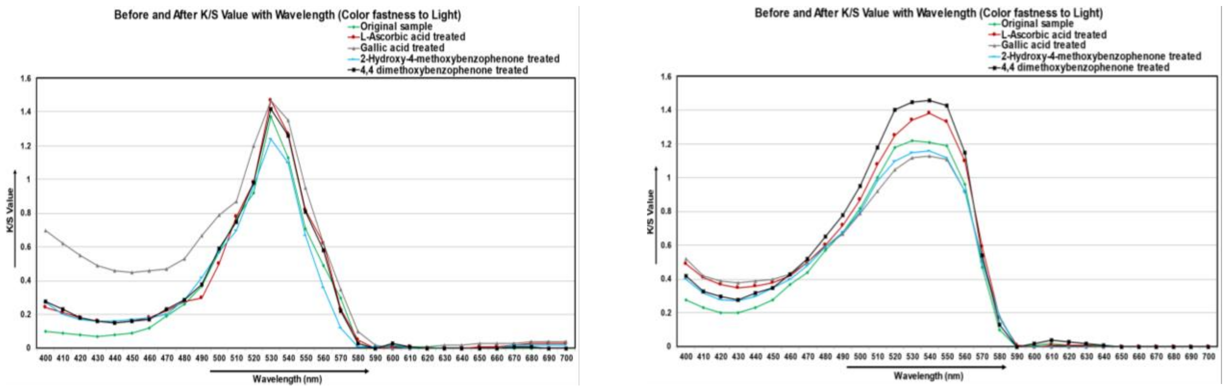
(a) (b)

Figure 7 Color fastness to rubbing of (a) 100% cotton and (b) cotton-polyester blended fabric



(a) (b)

Figure 8 Color fastness to light of (a) 100% cotton and (b) cotton/polyester blended fabric



(a) (b)

Figure 9 K/S value against wavelength of the color fastness to light of (a) 100% cotton and (b) cotton-polyester blended fabric

3.6 Color fastness to light of the 100% cotton fabric and cotton/polyester blended fabric

Color fastness to light for both 100% cotton and cotton/polyester blended fabric was improved after chemical treatment. Advanced fastness grade was observed in cotton/polyester blended fabric than 100% cotton (Figure 8(b)) for both treated and untreated samples. However, 2-H4-MB treated sample experienced a bit less fastness grading than other antioxidants and UV absorbers in both 100% cotton and cotton/polyester blended fabric. Error bar of color fastness to light is plotted within 95% confidence level where the error percentage of each grading is set at a maximum of 5%.

The color strength of 2-H4-MB treated sample was worse than other treated and untreated samples of 100% cotton fabric (Figure 9(a)). Specially GA showed an exceptional improved K/S value from 400-533 nm which also was investigated and proved by another research [23] where non-covalent bond-forming dyes/pigments showed enhanced color fastness to light of 100% cotton fabric.

But the presence of synthetic fiber in blended fabric (cotton/polyester), color strength of GA falls down noticeable for color fastness to light (Figure 9(b)). Not only that, LAA, 4-4DM showed higher K/S values than 2-H4-MB and GA treated samples.

4 CONCLUSION

Finishing of cotton and cotton-polyester blend fabrics with antioxidants and UV absorbers, all the chemicals show a great improvement in the color fastness to light properties as well as others washing, rubbing, water and perspiration properties. The overall K/S of two antioxidants, i.e., LAA and GA are 10% and 6% respectively which concludes that LAA is more preferable and acceptable than GA. At the same time, Between two UV absorbers, overall K/S value of 2-H4-MB and 4-4DB are 7% and 13% respectively. It ensures the performance of 4-4DB was comparatively better than 2-H4-MB. However, All the treated and untreated samples showed a color shifting tendency to red since the pigment color was light pink where presence of red color is higher than green and blue. The combined application with different ratio/percentage of antioxidants and UV absorbers for fluorescent pigment dyed fabrics will be studied in our further research.

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