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Research

Investigation of color yield & color space between different parts of a garments body

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***Abstract**: In textile dyeing industry, body part & accessories part of garments is dying in a same recipe & condition in a dyeing machine. Most of the time fabric type between body part & accessories is different. The objective of this work to finds out the color yield & space deviation between body part & accessories part fabric. By Kubelka-Monk theory, we explained the deviation between body part & accessories part of fabric in K/S, wavelength curve & difference in lightness and darkness (ΔL*), difference in red and green (Δa*), difference in yellow and blue (Δb*), total color difference (ΔE*) value for color space.*

***Keywords**: Body part & accessories part, same recipe & condition, color yield & space deviation, Kubelka-Monk theory, K/S, wavelength curve & ΔL* Δa* Δb* ΔE* value*

1. Introduction:

Bangladesh is one of the highest apparel exporters in world's textile market. For increasing aesthetic property of cloth coloration various types of dyes are used in garments. Color conceivably is one of the most significant features of textile materials. It is one of the basic

elements considered in textiles production, garment industries and decorative application. [1] Environmental influences like the weather, artificial light, laundering, ironing, body perspiration and others are connected to drastic color stability declining in textile products. [2] The color space measurement of garments is not only vital from the aesthetic point of view but also in determining any change that may arise and as well indicate an adjustment in some of its appearances that could lead to a desirable quality control in different parts of a garments body. [3] [4] Color space expresses color as three numerical values, L* for the lightness and a* and b* for the green to red and blue to yellow color components. CIELAB (Commission Inter-nationale de l'eclairage) was considered to be perceptually uniform with respect to human color vision; meaning that the similar quantities of numerical transformation in these values match to about the same quantity of visually perceived adjustment.CIE is the universal and commonly standardized color space that is able to perform mathematical conversion. The color measurement of different body part of garments will subsequently be used in the sample analysis and quality inspection where the sample will be used as process parameter to produce same or similar product. This will help in quality inspection to determine inconsistencies with respect to standards in authenticating the cause of irregularity if any. Wavelength bands have been assigned to the specific colors seen in the color spectrum. These are as follows

Table-1

Wavelength (nm)	Color
Less than 380	UV (not seen)
380-435	violet
435-480	blue
480-490	turquoise
490-500	bluish-green
500-560	green
560-580	yellowish-green
580-595	yellow
595-650	orange
650-780	red
Greater than 780	IR (not seen)

1.1Color Space:

It can be defined as the numerical comparison of a sample's color to the standard. It indicates the differences in absolute color coordinates and is referred to as Delta (Δ). These formulas calculate the difference between two colors to identify inconsistencies and help users control the color of their products more effectively.

1.2Identifying Color Space Using CIE L*a*b* Coordinates

- Defined by the Commission International de l'Eclairage (CIE), the L*a*b* color space was modeled after a color-opponent theory stating that two colors cannot be red and green at the same time or yellow and blue at the same time. As shown below, L* indicates lightness, a* is the red/green coordinate, and b* is the yellow/blue coordinate. Deltas for L* (ΔL*), a* (Δa*) and b* (Δb*) may be positive (+) or negative (-). The total difference, Delta E (ΔE*), however, is always positive.

- ΔL* (L* sample minus L* standard) = difference in lightness and darkness (+ = lighter, - = darker)
- Δa* (a* sample minus a* standard) = difference in red and green (+ = redder, - = greener)
- Δb* (b* sample minus b* standard) = difference in yellow and blue (+ = yellower, - = bluer)
- ΔE* = total color difference. To determine the total color difference between all three coordinates, the following formula is used: ΔE* = [ΔL*2 + Δa*2 + Δb*2]1/2 [5]

1.3 Kubelka-Monk theory

The kubelka-monk theory makes a relation between specular reflection and diffuse reflection of light by an equation. [7]

Specular reflection: When light comes in any surface an amount of light is absorbed by material & amount of light is reflected by material. When light is reflected in any specific angle, for example light reflected in a specific angle or direction at 80% and others different angle light is reflected at 20 %. Then it will be specular reflection of light. [8]

Diffuse reflection: when light is reflected in different angle, for example light is reflected in different angle or direction at 80 % and specific angle reflection is 20%. Then it will be diffuse reflection of light. [8]

If materials specular reflection light is K & Scattering reflection light is S,

Then,

$$\frac{K}{S} = \frac{[1 - 0.01\,R]^2}{2[0.01R]}$$

Here, R is reflection of light by material

If we get the reflection of light by material than we also find out the K/S value of material by maintain this equation. In spectrophotometer when we put the sample than a light source is applying on the sample and spectrophotometer find out the specular reflection and scattering reflection of material.

2. Materials:

Table-2

Chemical & material	**Specification or origin**
Dyes, Nonionic detergent, Neutral enzyme	Dysin,Bangladesh
Wetting agent , Peroxide stabilizer	Clarient , Bangladesh
Hydrogen peroxide, NaOH, Acetic acid	Merck,India,

Table-3

Fabric type	1x1 Rib
Dia& Gauge	18'& 38
Yarn count	30/1 Ne
GSM	150
Composition	50% viscose & 50% polyester
Heat set parameter(dwell time & temp)	185^0C & 25s

Table-4

Fabric type	Single jersey
Dia& Gauge	28' & 32
Yarn count	30/1 Ne

GSM	210
Composition	50% viscose 50% polyester
Heat set parameter(dwell time & temp)	185^0C & 25s

Both 1x1 Rib & Single jersey fabric was collected from local market of Bangladesh.

3. Methods:

3.1Dyeing of viscose part of blend fabric (1x1 Rib & Single jersey) with Reactive dye

Only viscose part of blend fabric was dyed. Auto dispensing m/c was used on this project to measure the accurate amount of chemicals &dyes. Dyeing process occurred on Sample dyeing machine, Thies, Germany.

Dyeing process was occurred in different stages for different colors in sample dyeing machine. Every time recipe was similar.

Amount of dye used in for i) Blue- 200gm.

ii) Orange-200gm (Red-100gm & Yellow-100gm)

iii) Grey color -200gm (Red-66gm & Yellow-67gm& Blue-67gm)

Table-5: Recipe of scouring & bleaching process

Wetting agent	100gm
Nonionic detergent	200gm
Stablizer	100gm
NaOH	250gm
H_2O_2(3%)	400gm
Temperature	90^0C
Time	40min
M:L	1:10
Sample weight	10kg

Table-6: Recipe of Viscose part dyeing process

Wetting agent	100gm
Leveling agent	100gm
Nonionic detergent	200gm
Stablizer	100gm
NaOH	250gm
NaCl	300gm
Temperature	90^0C
Time	40min
M:L	1:10
Sample weight	10kg

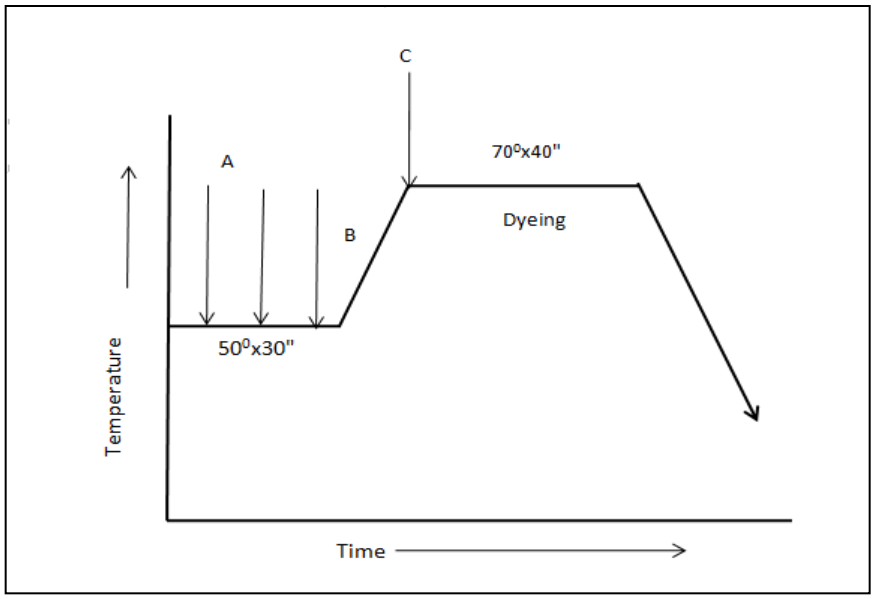


Figure 3.1**:** Dyeing process curve of viscose fabric

A = All chemicals of dyes was dosing at 50^0C

B = Temperature gradient was used 3^0C/min

C = Soda ash dosing at 70^0C

Here, both single jersey & 1x1 rib fabrics dyed altogether respectively, primary color of blue, secondary color of orange & tertiary color of grey.

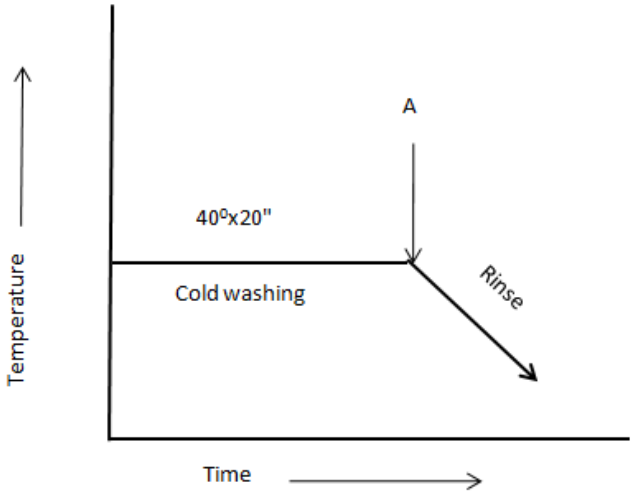


Figure 3.2**:** Washing process curve of viscose fabric

A = Drainage after 20 min of washing

Figure 3.3: Sample Dyeing Machine

3.2 Drying of Single jersey & 1x1 Rib fabric with Stenter Machine

Figure 3.4: Stenter Machine

3.3 Machine Description & Parameters

Dry Process was occurred in stenter machine, Monforts, Germany. It is a 8 chamber stenter machine. Where, existence of 8 burner & 16 blower. Every burners contains 160° temperature. All blower setting was 80/80.

3.4 Prepare a Polo shirt with Single jersey fabric & 1x1 Rib fabric

Polo shirt was made by a standard human body measurement for blue, orange & grey color dyed fabric.

Figure 3.5 Polo Shirt

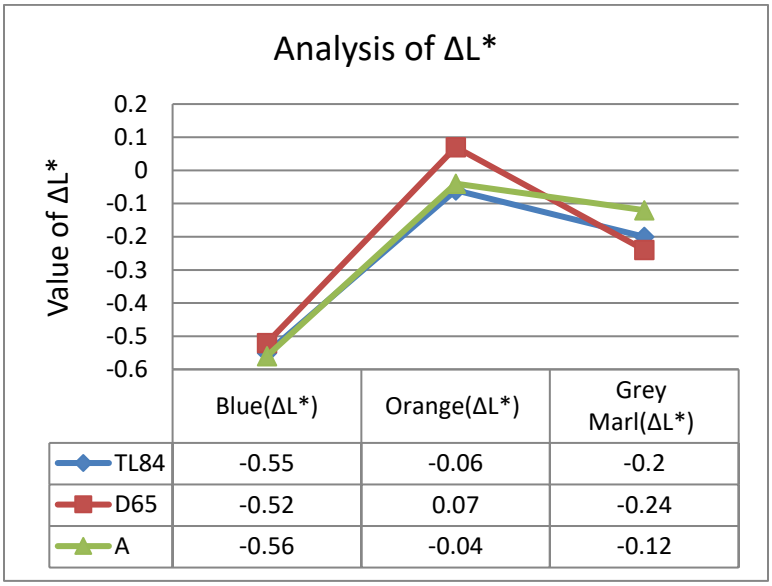
Here, Collar & cuff of this polo t-shirt made by 1x1 Rib fabric. Main body of this polo t-shirt made by single jersey fabric.

4. Results

4.1 Analysis of color space with Data color-400 spectrophotometer

Here, single jersey fabric used as a standard fabric sample & 1x1 Rib fabric used as a test sample.

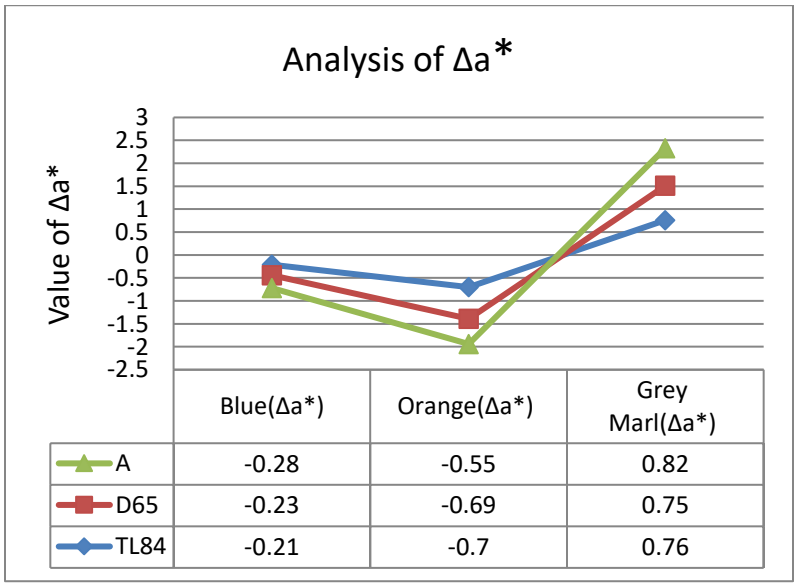
The determination of colors pace or color difference used by Data color-400 spectrophotometer.



	Blue(ΔL*)	Orange(ΔL*)	Grey Marl(ΔL*)
TL84	-0.55	-0.06	-0.2
D65	-0.52	0.07	-0.24
A	-0.56	-0.04	-0.12

Fig 4.1 Value of ΔL*

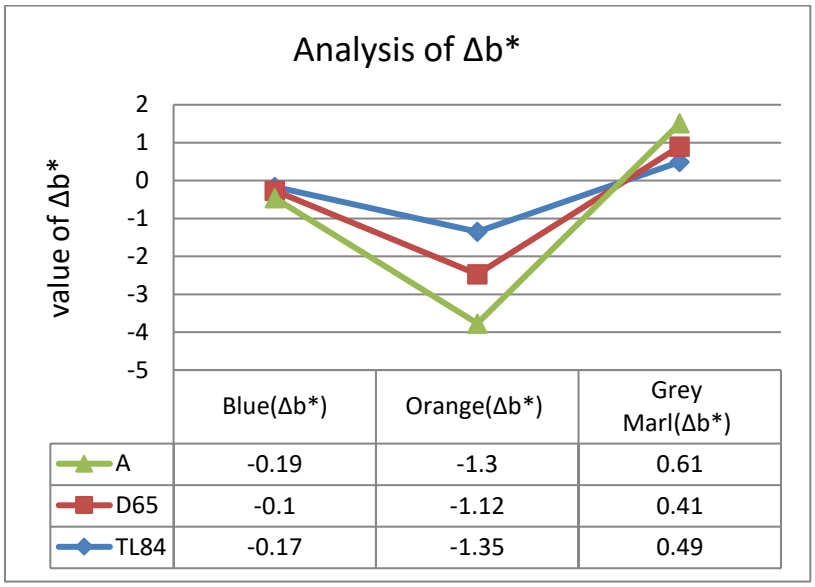
Here, ΔL* indicate that Primary color of blue has more darker in compare to secondary color of orange & grey marl inconsideration of both single jersey & 1x1 Rib fabric with different light source.



	Blue(Δa*)	Orange(Δa*)	Grey Marl(Δa*)
A	-0.28	-0.55	0.82
D65	-0.23	-0.69	0.75
TL84	-0.21	-0.7	0.76

Fig 4.2 Value of Δa*

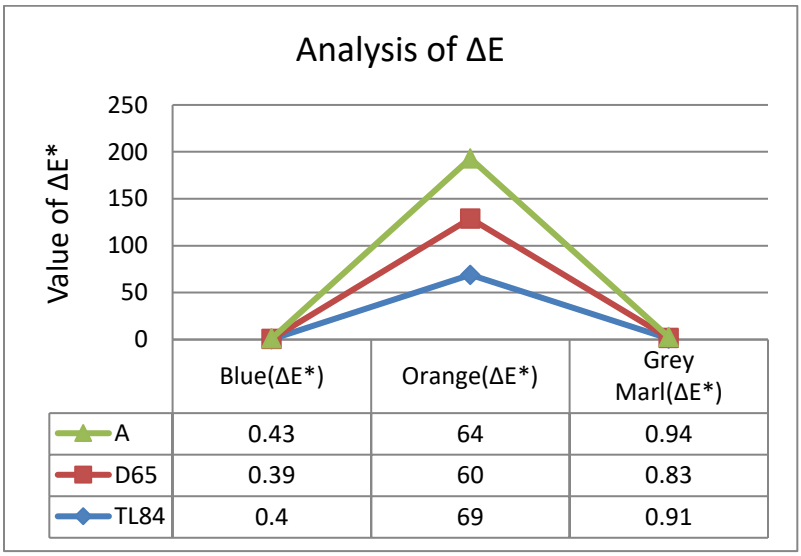
Here, Δa* indicate that Primary color of blue has less greener in compare to secondary color of orange but grey marl has redder inconsideration of both single jersey & 1x1 Rib fabric with different light source.



	Blue(Δb*)	Orange(Δb*)	Grey Marl(Δb*)
A	-0.19	-1.3	0.61
D65	-0.1	-1.12	0.41
TL84	-0.17	-1.35	0.49

Fig 4.3Value of Δb*

Here, Δb* indicate that Primary color of blue has less bluer in compare to secondary color of orange but grey marl has yellower inconsideration of both single jersey & 1x1 Rib fabric with different light source.



	Blue(ΔE*)	Orange(ΔE*)	Grey Marl(ΔE*)
A	0.43	64	0.94
D65	0.39	60	0.83
TL84	0.4	69	0.91

Fig 4.4 Value of ΔE*

Here, finally ΔE*indicate that blue color has the less color space or color difference in between single jersey & 1x1 Rib fabric compare to grey marl & orange color with different light source.

4.2 Spectrophotometric Analysis of dyed fabric

The determination of specific k/s (%) of light on dyed fabric was carried by Spectrophotometer-400, Dhaka, Bangladesh. According to **Kubelka-Monk theory**, We presented k/s value wavelength of visible light (400nm-700nm).Maximum pick value of Red (740 to 635 nm), Orange (635 to 590 nm), Yellow (590 to 560 nm), Green (560 to 520 nm), Cyan (520 to 490 nm), Blue (490 to 450 nm), Violet (450 to 400 nm) region light is exist on 6.1, 6.2, 6.3, 6.4, 6.5, 6.6.

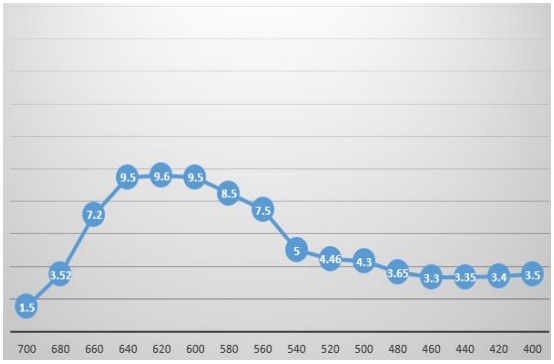


Fig 4.2.1 K/S& Wavelength curve of Single jersey blue colored fabric

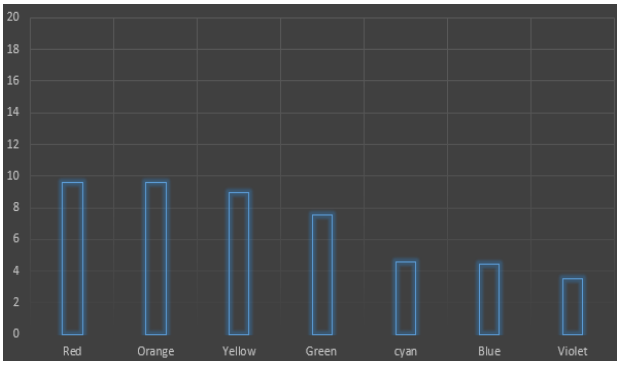


Fig 4.2.2 Connection of Specific L Single jersey blue

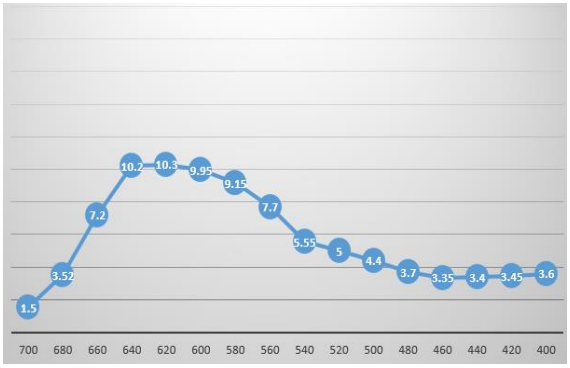


Fig4.2.3K/S & Wavelength curve of 1×1 Rib fabric blue colored fabric

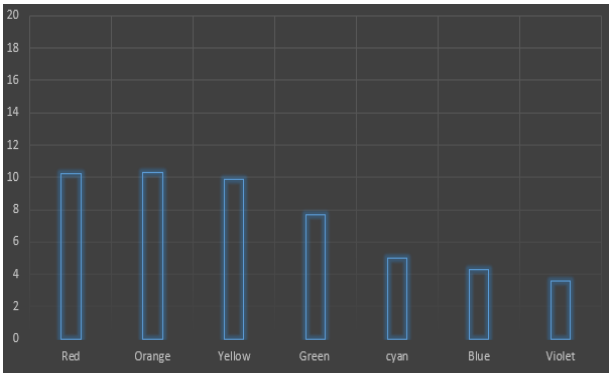


Fig 4.2.4 K/S & Wavelength curve of 1×1 Rib fabricblue colored fabric

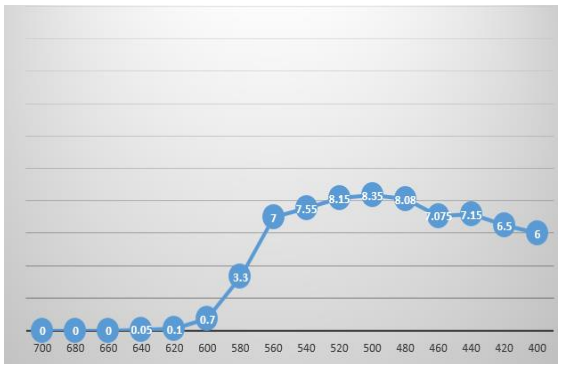


Fig 4.2.5 K/S & Wavelength curve of Single jersey Orange colored fabric

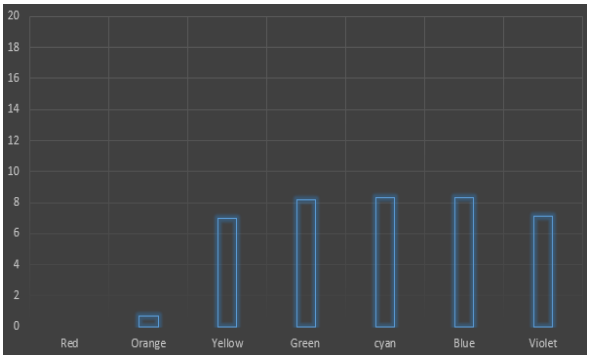


Fig 4.2.6 Connection of Specific Light K/S of Single jersey Orange colored fabric.

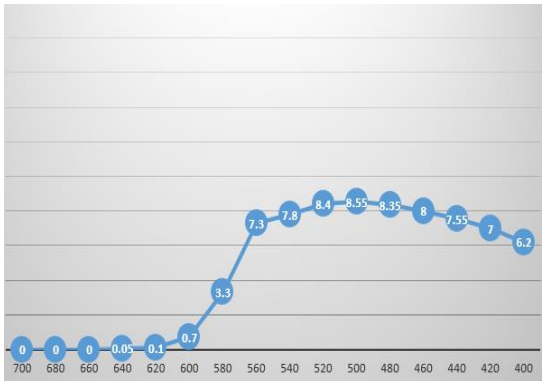


Fig 4.2.7 K/S & Wavelength curve of 1×1 Rib fabric Orange colored fabric.

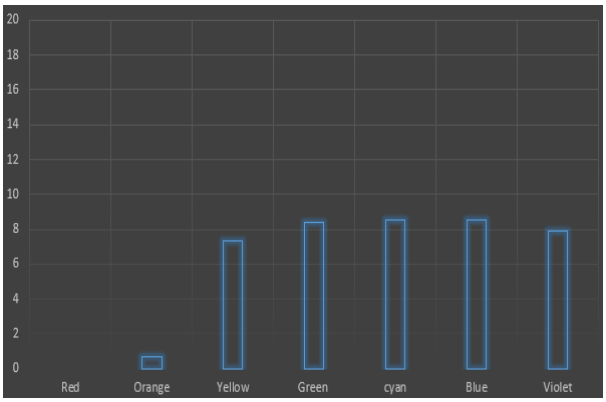


Fig 4.2.8 Connection of Specific Light K/S of 1×1 Rib Orange colored fabric.

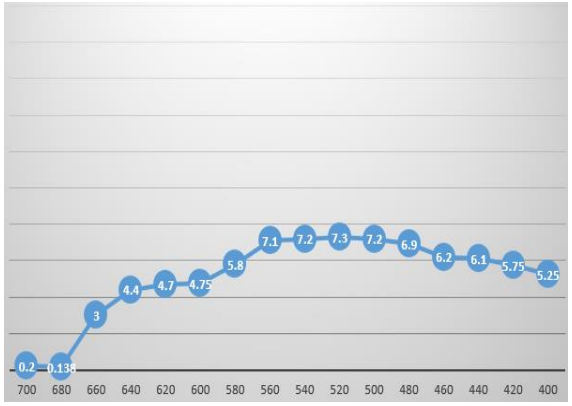


Fig 4.2.9 K/S & Wavelength curve of Single jersey Grey colored fabric

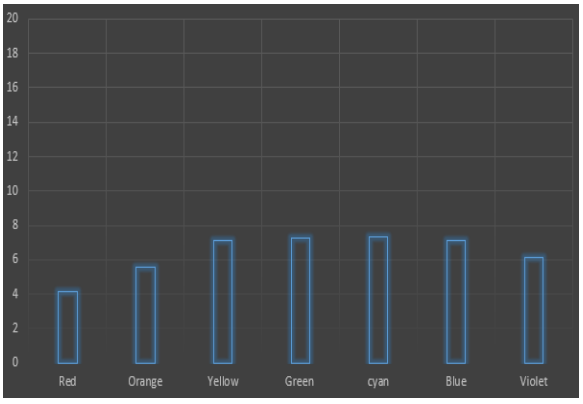


Fig 4.2.10 Connection of Specific Light K/S of Single Jersey Grey colored fabric

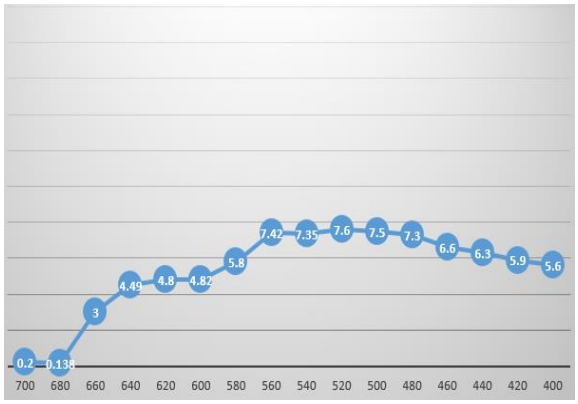


Fig 4.2.11 K/S & Wavelength curve of 1×1 Rib fabric Grey colored fabric

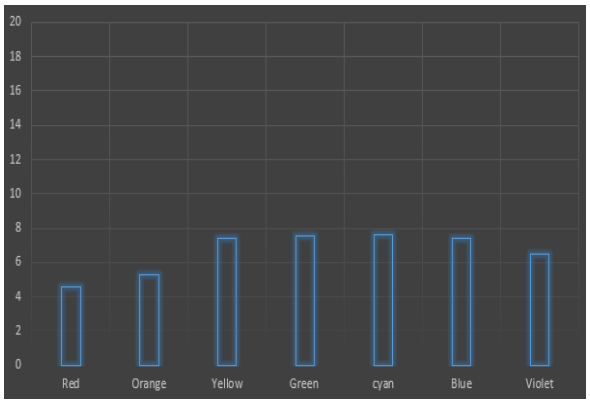


Fig 4.2.12 Connection of Specific Light K/S of 1×1 Rib Grey colored fabric.

K/S & wavelength curve of blue color dyed Single jersey &1×1 Rib fabric exists on fig 4.2.1 & 4.2.3. After analyzing the curve fig 4.2.2, 4.2.4 was found. In fig 4.2.4 where Red, Orange, Yellow, Green, Cyan, Blue, Violet light compare to fig 4.2.2 k/s (%) of light higher than 6.25 times,7.29 times, 9.91 times, 1.98 times, 9.64 times, 0.22 times, 2.85 times.

Similarly, Orange color dyed Single jersey &1×1 Rib fabric exists on fig 4.2.5 & 4.2.7. After analyzing the curve fig 4.2.6, 4.2.8 were found. In fig 4.2.8 where Red, Orange, Yellow, Green, Cyan, Blue, Violet light compare to fig 4.2.6 k/s (%) of light higher than 0.1 times,4.54 times, 4.28 times, 3.06 times, 2.39 times, 2.53 times, 10.21 times.

Again, Grey color dyed Single jersey &1×1 Rib fabric exists on fig 4.2.9 & 4.2.11. After analyzing the curve fig 4.2.10, 4.2.12 were found. In fig 4.2.12 where Red, Orange, Yellow, Green, Cyan, Blue, Violet light compare to fig 4.2.10 k/s (%) of light higher than 10.43times,0.71 times, 4.5 times, 4.13 times, 4.24 times, 4.23 times, 4.87 times.

5. Discussions

Every time 1x1 Rib fabric's color yield & color build up seems higher than Single jersey fabric for primary, secondary & tertiary color. Every time 1x1 Rib fabric's GSM was higher than S/J fabric. Higher the GSM of fabric indicates the higher fixation of dyes in fabric's surface.

6. Conclusion

The present study shows that color yield & color build up for Collar & Cuff of a garments body is higher than the main body part of a garments. According to Kubelka-Monk theory, we tried to give an explanation. But in a garments body variation of this color yield & color build up is acceptable for consumers.

7. References

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