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Preliminary study on the correlation between color measurement of dyed polyester and its image files

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Abstract. As the internet becomes more popular, buyers send image files to manufacturers instead of sending swatches. However, this method may cause problems because different from the monitor between the buyer and the manufacturer, and also there is a problem depending on the light source. In order to overcome these problems, we investigated the relationship between color measurement values of dyed fabrics and RGB values of image files. The RGB values of image files tended to decrease with increasing dye concentration in all three colors. Correlation between RGB values and a*, b* values was observed at low concentration, but there was little correlation at high concentration. In the case of yellow color, there is no correlation between the L*a*b* values obtained from the dyed fabric and RGB values obtained from the image file.

1. Introduction

In traditional dyeing process, the buyer sent the swatch directly to the manufacturer by parcel service, and the manufacturer did the coloring of the fabric to match the color. It took about two weeks to get the correct color from the time it was mailed, get confirmation from the buyer, and start mass production over 10,000 yards. But since the Internet has become popular, buyers are sending image files instead of sending swatch directly to manufacturer. The total production time is shortened because there is no need to send swatch. However, this method has the following problems. Firstly, the colors appear differently on the monitor because the monitor is different between the buyer and the manufacturer. Secondly, when make image file is created by shooting with a digital camera, the color of image changes depending on the shooting environment such as light source, illumination and moisture content of the sample. Finally, when the color is matched by the naked eye, there is a problem that the color differs depending on the light source [1]. In order to overcome these problems, we investigated the relationship between color measurement values and RGB values. We obtained CIE L*a*b* values by measuring L, a, b values of dyed PET (Polyethylene terephthalate) fabric with a spectrophotometer, and scanned the dyed fabric to create image file. The obtained CIE L*a*b* values were converted into RGB values by various formulas in order to compare with the RGB values of the image file.

2. Experimental

All chemicals such as sodium hydrosulfite, sodium hydroxide, acetic acid were laboratory grade reagents. The PET fabrics were dyed using disperse dyes (Red – C.I. Disperse Red 152, Blue - Unknown, Yellow – C.I. Disperse Yellow 114) in an IR dyeing machine at a liquor-to-goods ratio of 1:20. The dyebaths were prepared with various concentration of dyes (0.1 – 7 % o.w.f). Dyeing was commenced at 60 ℃. The dyebath temperature was raised at a rate of 1 ℃/min to 130 ℃, maintained at this temperature for 60 min and rapidly cooled to room temperature. The dyed fabrics were reduction-cleared (1 g/l sodium hydroxide, 1 g/l sodium hydrosulfite at 80 ℃ for 20 min).

The conversion from XYZ to L*a*b* was calculated using the following equation [2,3,4].

CIE L*a*b* $L^* = 116f\left(\frac{Y}{Y_n}\right) - 16,\ a^* = 500\left[f\left(\frac{X}{X_n}\right) - f\left(\frac{Y}{Y_n}\right)\right],\ b^* = 200\left[f\left(\frac{Y}{Y_n}\right) - f\left(\frac{Z}{Z_n}\right)\right]$ (1)

Where $f(s) = s^{1/3}$ for s>0.008856

and $f(s) = 7.787s + 16/116$ for s≤0.008856

Hunter L*a*b* $L^* = 100\sqrt{\frac{Y}{Y_n}},\ a^* = K_a\left(\frac{X/X_n - Y/Y_n}{\sqrt{Y/Y_n}}\right),\ b^* = K_b\left(\frac{Y/Y_n - Z/Z_n}{\sqrt{Y/Y_n}}\right)$ (2)

Where X, Y, and Z are the CIE tristimulus values.

X_n, Y_n, and Z_n are the tristimulus values for the illuminant.

K_a, K_b are chromaticity coefficients for the illuminant.

The image files of dyed fabrics were scanned by Epson scanner and the RGB values were obtained from the image file using Adobe Photoshop [5]. The color parameter of dyed polyester fabrics were determined on a Macbeth Coloreye 3300 spectrophotometer, under standard illuminant D65 using the 10˚ standard observer.

3. Results and Discussion

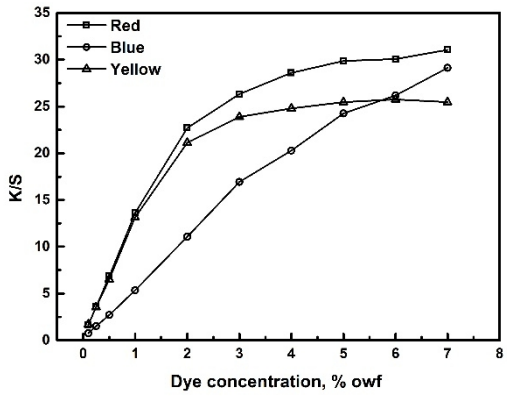


Figure 1. Effect of dye concentration on the color yields of dyes.

Figure 1 shows the build-up of the dyes on PET fabrics. The color yield of red and blue dyes continuously increased as concentration of dyes increased suggesting that red and blue dyes have a good build-up property. However, yellow dye shows limited build-up and reached saturation at 3-4 %owf. Therefore, it is necessary to replace the yellow dye into a dye with good build-up property.

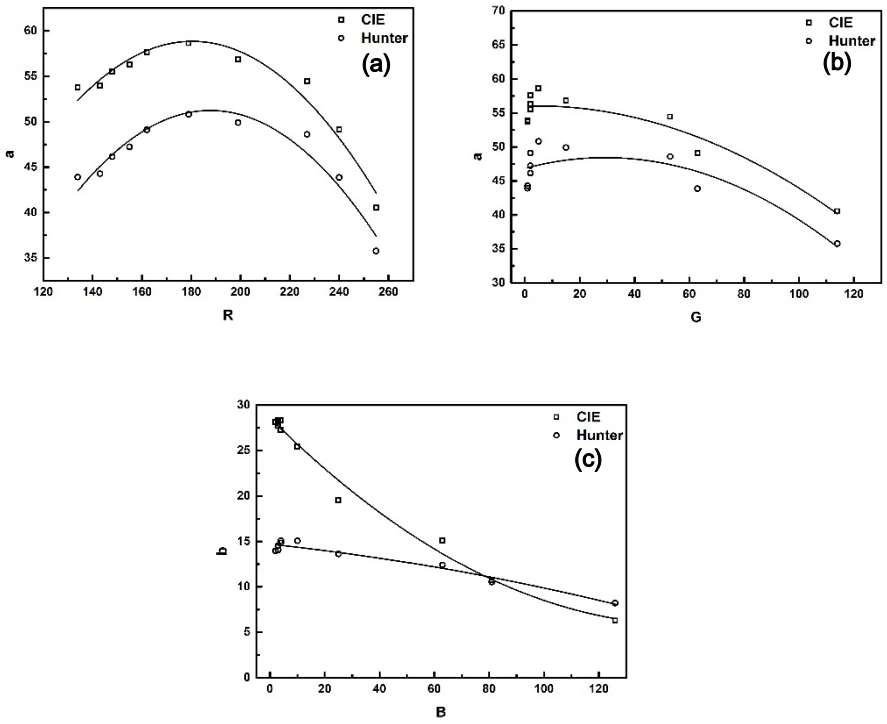
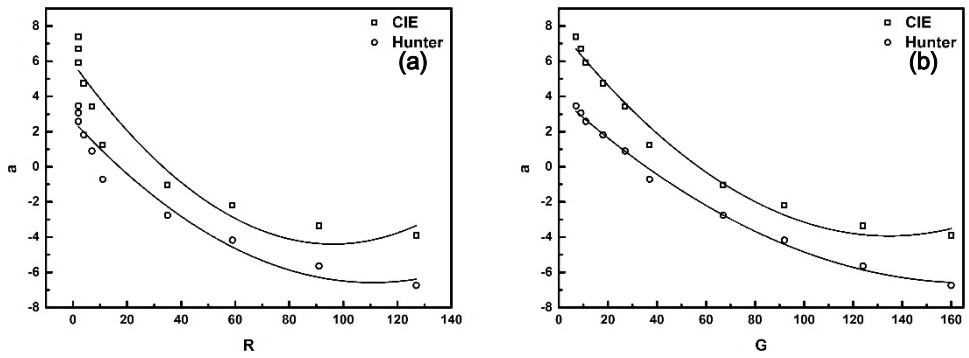


Figure 2. The relationship between RGB from image file and L*a*b* values of red dye on PET fabric according to dye concentration. (a) R-a (b) G-a (c) B-b

The RGB and L*a*b* values of red dye on PET fabric is shown in Figure 2. In the red color, the RGB values decrease as the dye concentration increases. As the dye concentration increases, the value of a* increases until 2 %owf and then decreases. In Figure 2 (c), the b* value increases as the dye concentration increases. When the dye concentration is low, the slope of the curve obtained from the dyed fabric and the image file is similar. However, when the concentration of the dye is high, the values of a* and b* don't fit well with the trendline because the RGB value can't represent a negative value and is replaced with zero.



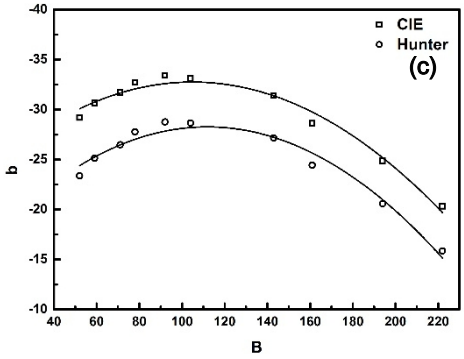


Figure 3. The relationship between RGB from image file and L*a*b* values of blue dye on PET fabric according to dye concentration. (a) R-a (b) G-a (c) B-b

The RGB and L*a*b* values of blue dye on PET fabric is shown in Figure 3. In the blue color, the RGB values also decrease as the dye concentration increases. The a* value increases as the dye concentration increases. As the dye concentration increases, the value of b* increases until 3 %owf and then decreases. When the dye concentration is low, the slope of the curve obtained from the dyed fabric and the image file is similar. However, when the concentration of the dye is high, the values of a* don't fit well with the trendline. This can also be explained using the limits of the RGB value range. Unlike red color, b* values are well suited to trendlines even at high concentration of dye, which is probably due to the good build-up property of blue dye.

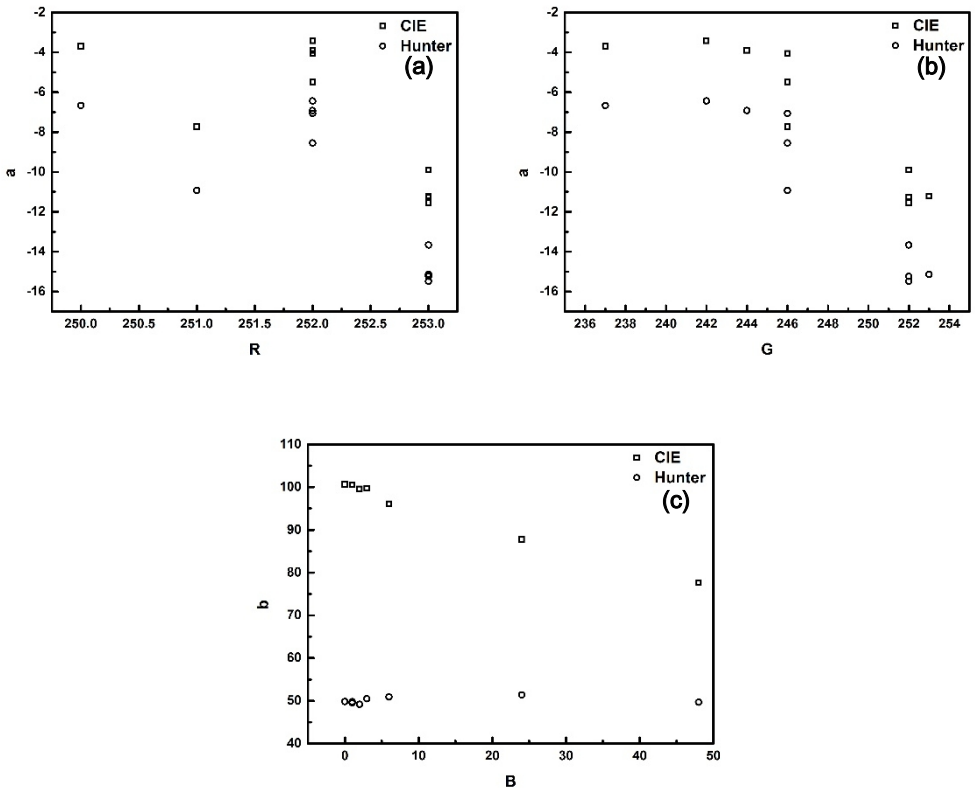


Figure 4. The relationship between RGB from image file and L*a*b* values of yellow dye on PET fabric according to dye concentration. (a) R-a (b) G-a (c) B-b

The RGB and L*a*b* values of yellow dye on PET fabric is shown in Figure 4. In the yellow color, the RGB values also decrease as the dye concentration increases. However, yellow color is less similar at low concentrations than other colors. Especially at high concentration, there is no tendency because yellow dye reaches saturation at 3-4 %owf and have limited build-up property.

4. Conclusions

All the dyes showed good build-up property except yellow dye. The RGB values tended to decrease with increasing dye concentration in all three colors. The CIE values are better than the Hunter values for this preliminary study. At low concentrations, a* and b* values fit well with trendlines, but not at high concentrations. In the case of yellow color, there is no tendency between the L*a*b* values obtained from the dyed fabric and RGB values obtained from the image file. From these results, we looked some possibility of using image files instead of swatches in the dyeing process. We need to examine some dyes further more.

References

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