Comparation Study of Color Reading Method in Gambier Extract Dyed Batik Fabric

Vivin Atika[1], Agus Haerudin[1] and Zohanto Widyantoko[1]
[1]*Centre for Handicraft and Batik, Ministry of Industry, 7th Kusumanegara Street, Yogyakarta*

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Abstract: Colour reading has an important role in the study of natural colours on batik, because it is one of few methods in determining the quality of a dye performance in batik fabric. The commonly used method is using visible ultra violet spectrophotometer that requires substantial cost and complicated operation system. This study aims to determine the performance method comparison between visible ultra violet spectrophotometer and mathematical count from digital images as colour difference test method to evaluate the quality of batik's natural colours from Gambier extract. We have done sample dyeing from previous research and doing colour difference test by spectrophotometer. Then we take the sample picture by scanner and measure the L*a*b* values. We count the colour difference from L*a*b* values using mathematics equation. The L*a*b* and ΔE values from both method are compared by statistical t test and ANOVA test. From the results it was found that the colour difference value of both methods differ significantly, but each method gave good performance to measure the colour difference. However, it should be noted that the RGB space model depends on the input, so the more accurate the digital image with the original sample, the value will be closer to the colour difference values of laboratory measurements.

1 INTRODUCTION

Natural dyes batik is favourite because of its unique, exotic and tender, yet classic nuance colouring. Dewi (2006) in Setiawan, et al (2018) said that dyeing is also take part in determining the quality of the batik. Colour reading has a colouring quality on natural dyes of batik fabric. In batik the colour reading is there are a few methods such as colour intensity and colour different test. Colour intensity and colour different tests were conducted using an ultraviolet visible spectrophotometer. Colour is calculated using reflectance data (%R) that is converted into (K/S) score. The (K/S) score is approximately amount of colour absorbed in the batik fabric. In colour measurement methods using the colour reading method of L*a*b* colour space with the results hue and chrome.

Digital images are taken by electronic media such as digital cameras, scanners, smartphones, etc. The used colour space models are RGB and L*a*b*. RGB colour model space is using transmitted light to perform colour. Vary compositions and intensity of three prime colours, green and blue are used to make colours cyan, magenta, yellow, and white. This model is applied by television and computer screens, where coloured pixels are produced by red, green and blue electron shots on screen. It really depends on the apparatus performer.

Colour space models International standards developed by Commission International d'Eclairage (CIE) on 1976. L*a*b* is composed by luminance component or lightness (L score = 0-100) with two chrome components (-120 to +120): component a, from green to red and component b, from blue to yellow. L*a*b* colour space is independent from the apparatus, but the result is the input or apparatus that produces images (Yam and Papadakis, 2004). Besides, in L*a*b* colour space the colour perception is uniform, so the Euclidean distance between two colours approximately equal to the colour difference accepted by human eyes. This model has a wider coordinates compared to RGB or CMYK.

The use of digital images as an analytical tool has been widely used, such as in the fields of health (Tam and Lee, 2012) and food (Tahir, et al., 2007; Larrain, et al, 2008, Magdić, et al., 2009; Trinderup and Kim, 2015). Digital image of objects are taken using digital cameras with certain specifications. RGB data is

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taken from digital images in JPEG format and converted into L*a*b* values using sequential transformation from RGB to CIE L*a*b* (Konica Minolta, 1998).

Natural colours come from the extracts of plant parts, animal waste, and minerals. Natural colour is obtained by extraction using solvents, either by heating or not (Pujilestari, et al., 2016). The compound content in it is very complex, so the colour distribution is not broad and tends to be uneven. In addition, it is very difficult to reproduce the same colour using single natural dyes. So to produce a good colour, repeated inspections are needed.

Commercial colour measurement involves certain instruments that require high costs and are not easy to operate. Natural colouring still experiences problems in colour uniformity, so that practical methods are needed in colour reading that can be carried out repeatedly. Batik optical signals from natural colouring can be used as digital images using various devices such as colour sensors, cameras and ordinary scanners.

The purpose of this study is to determine the performance method comparison between visible ultra violet spectrophotometer and mathematical calculation from digital images as colour difference test method to evaluate the quality of batik's natural colours from Gambier extract.

2 RESEARCH METODOLOGY

2.1 Experimental Design and Sampling

Samples used in this study were 12 pieces. They were cotton and silk dyed with Gambier extract. Gambier extract obtained by heat extracting at temperature of 100°C for 2 hours using water and cold soaking with alcohol for 4 days. The extract was then used to dye the fabric by 6 times dipping. The dyed fabric were putting into post-mordant using fixative agent alum, ferrous sulphate and limestone.

2.2 Colour Measurements

Existing samples were measured for colour reading using spectrophotometry to determine the value of the lightness (L*), redness (a*) and yellowness (b*). This value will be the real L*a*b* value. Digital image of the samples were taken using canon LiDE 120 scanner with optic resolution specification 2400 x 4800 dpi and 16 bit deep for each colour. The estimated L*a*b* value were obtained from digital image of samples using mathematical calculation approach.

RGB colour measured from digital image, then converted into CIE L*a*b* colour space using the sequential transformation from sRGB to $XYZD_{65}$ to XYZ_C (Pascale, 2003 in Larrain et al., 2008) and from XYZ_C to CIE_C L*a*b* (Konica Minolta, 1998 in Larrain et al., 2008). The subscript letter referring to illuminator used.

Referring to Larrain et al. (2008), sRGB value were linearized by dividing with 255 and then applying a decoding exponent of 2.2. This decoding exponent corresponded to 1/γ using a simple encoding γ of 0.45. Then, linear sRGB was converted to XYZD65 using the matrix transform (Pascale, 2003):

$$\begin{bmatrix} X_{D65} \\ Y_{D65} \\ Z_{D65} \end{bmatrix} = \begin{bmatrix} 0.4125 & 0.3576 & 0.1804 \\ 0.2127 & 0.7152 & 0.0722 \\ 0.0193 & 0.1192 & 0.9503 \end{bmatrix} \times \begin{bmatrix} R \\ G \\ B \end{bmatrix} \quad (1)$$

Then XYZD65 was converted to XYZC using the Bradford matrix transform (Pascale, 2003)

:

$$\begin{bmatrix} X_C \\ Y_C \\ Z_C \end{bmatrix} = \begin{bmatrix} 1.0098 & 0.007 & 0.0128 \\ 0.0123 & 0.9847 & 0.0033 \\ 0.0038 & -0.0072 & 1.0892 \end{bmatrix} \times \begin{bmatrix} X_{D65} \\ Y_{D65} \\ Z_{D65} \end{bmatrix} \quad (2)$$

Finally, the following equations were used to convert XYZC to CIEC L*a*b* (Konica Minolta, 1998):

$$\begin{aligned} L^* &= 116 \times (Y/Y_n)^{1/3} - 16 \\ a^* &= 500 \times [(X/X_n)^{1/3} - (Y/Y_n)^{1/3}] \\ b^* &= 200 \times [(Y/Y_n)^{1/3} - (Z/Z_n)^{1/3}] \end{aligned} \quad (3)$$

Where Xn, Yn, and Zn are the values for X, Y, and Z for the illuminator used, in this case 0.973, 1.000, and 1.161 respectively. Also, (X/Xn)1/3 was replaced by [7.787 x (X/Xn) + 16/116] if X/Xn was below 0.008856; (Y/Yn)1/3 was replaced by [7.787 x (Y/Yn) + 16/116] if Y/Yn was below 0.008856; and (Z/Zn)1/3 was replaced by [7.787 x (Z/Zn) + 16/116] if Z/Zn was below 0.008856 (Konica Minolta, 1998).

The real and estimated value of L*a*b* from the sample are then calculated for colour difference (ΔE) using the following formula:

$$\Delta E = \sqrt{((\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2)} \quad (4)$$

All values were collected in form of data group to be used for further analysing.

2.3 Statistical Calculation

Statistical analysis was performed using the t-test and ANOVA using α = 0.05, with the hypothesis that there were no significant differences between groups of real and estimated data of each value of L*, a*, b* and ΔE also the measuring tool were giving the same effect on calculated values.

Data was then plotted to find out the linear regression equation and provided a correlation coefficient (R). Thus we could find how much the relationship/correlation between treatment, real and estimated value of L*, a*, b*, and ΔE. The relation of each data were used to described the comparison of performance colour reading method by spectrophotometry and digital image analysis using mathematical calculation.

3 RESULTS AND DISCUSSIONS

3.1 L*a*b* Scores

The measurements results are in the form of real and estimated data groups from 12 fabric samples and digital images. Data images and each data group consists of L*, a*, b* values are presented in Table 1.

3.2 ΔE Score Analysing

The value of ΔE obtained from 12 samples were amount to 66 pieces of data. The analysis was carried out by the t-test and ANOVA statistical method. The t-test hypothesis used is that there is no difference between the real and estimated ΔE value, with the H_0 starting criterion when t count < t table. The result is t count = 8.10 > from t table = 2.39, H_0 is rejected. Statistical calculations ANOVA test with α = 0.05 and hypothesis that there are no significant different effect between measuring tools and calculated data. The result of ANOVA test is, P value = 1.9072 E-11 < α = 0.05, H_0 is rejected. The two statistical analysis results means that the real data is different from the estimation, so the results of direct measurements from the fabric using spectrophotometers and measurements using digital images are significantly different. Moreover the both measuring tools were giving different effect on data.

The data are then plotted to find out its linear regression equation, by giving a correlation coefficient (R) = 0.94, so that between treatment, real and estimation value of ΔE, there are quite relationship/correlation. This is in accordance with Figure 1, which in the graph shows the same trend between real and estimated ΔE.

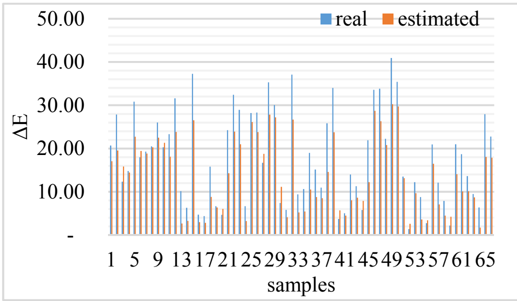


Figure 1: Graphic of real versus estimated ΔE

3.3 Lightness Score Analysing

Lightness (L*) single scores are analysed with statistical t-test and ANOVA calculations. From t-test results, obtained t score = 0.32 > from t table = 2.72, so that H_0 is accepted. From ANOVA test with α = 0.05, giving P value = 0.76 > α = 0.05. So, H_0 is accepted. Both t-test and ANOVA doesn't show any significant differences between real and estimated L* value.

The data are plotted to find out the linear regression, by giving correlation coefficient (R) = 0.97, so that between variables, real and estimated L* there are relation/correlation. This is in accordance with Figure 2, which is in the graphic showing the same trend between real and estimation.

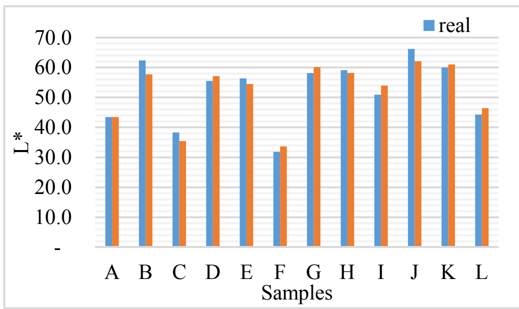


Figure 2: Graphic of real versus estimated L*

3.4 a* Score Analysing

The value of redness (a*) is analysed statistically by the t test. From the results of the t test, the value of t = 6.68 > from t table = 2.72, so that H_0 is rejected. From ANOVA test with α = 0.05, giving P value = 0.000035 < α = 0.05. So, H_0 is rejected. Both test result shows that there is a difference between real a* and estimated a*. The two colour measuring tool also gives difference effect to form data results.

The data plotted to find out the linear regression equation, providing R = 0.97. Between treatment, real and estimated a* value is having correlation or showing the same trend, in accordance with Figure 3.

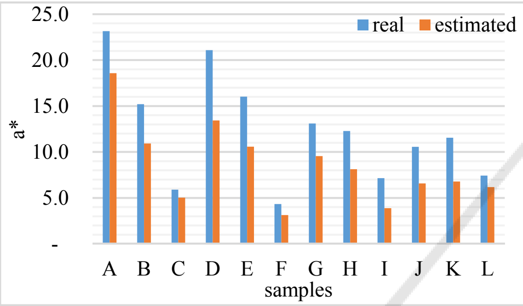


Figure 3: Graphic of real versus estimated a*.

3.5 b* Score Analysing

The value of yellowness (b*) is analysed using the t test. From the results of the t test, the value of t count = 6.19 > from t table = 2.72, so that H_0 is rejected. ANOVA test with α = 0.05, giving P value = 0.000068 < α = 0.05. So, H_0 is rejected. This also shows that there are any significant difference between real and estimated b* value. Both measuring tool also gives difference effect on resulting the data.

Linear regression from data provides R = 0.91. Treatment, real and estimation value of b* are having correlation. This is in accordance with Figure 4, where the real and estimated data both shows the same trend on the graphic.

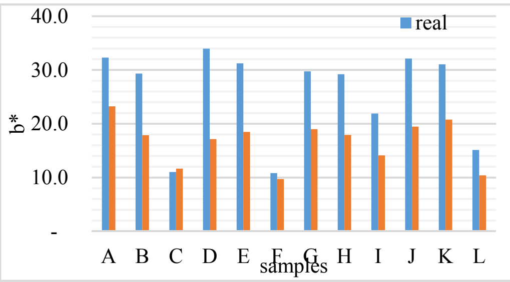


Figure 4: Graphic of real versus estimated b*.

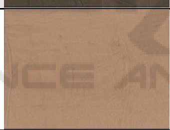
From the statistical calculation t-test and ANOVA for ΔE, a* and b*, there are significantly difference performance on two measuring tool in resulting colour reading data but highly correlated.

The difference on data results can be caused by difference source of subject that are measured. Spectrophotometer measure directly from existing dyed fabric and mathematical calculation estimate colour reading value from digital image. There are bias in measurement because of few factors. Digital image are RGB based. The L*a*b*'s colour space cover larger gamut compared to RGB. So that L*a*b* readings from RGB digital images cannot show precise colour coordinates location (Yam & Papadakis, 2004). The use of image converter as input/input for reading RGB values to the sample lab also has an effect. Light source of the measuring tool can also give effect on measuring data results. Illuminator C in colorimeter puts more emphasis on the red portion of the light spectrum than cool white fluorescent light in digital image converter (Larrain, et al., 2008).

In this study, L* statistical calculation shows no difference performance. Yet in linear regression plotting, all data give high R. Means that both measuring tools are correlated. O'Sullivan, et al. (2003) and Larrain, et al. (2008) said that in their study instrumental colour measurements taken from digital images were more highly correlated than colorimeter values. This is due to possibility of full surface evaluation of digital images will get more representative sampling.

From the result, even though there are bias, digital image can be used as simple and easy method to predict or estimate L*a*b* and colour difference value for natural batik dyed fabric inspection. The choice of the right digital image converter also influence the result of measurement. The more it can convert closely to real image, the more precise the value obtained.

Table 1: Group of real and estimated L*a*b* scores of cotton and silk dyed with Gambier extract.

Samples	Digital Image	Value of measurements					
		Real L*	Estimated L*	Real a*	Estimated a*	Real b*	Estimated b*
A		43.46	43.43	23.16	18.58	32.30	23.24
B		62.34	57.69	15.21	10.92	29.32	17.88
C		38.32	35.43	5.89	5.02	11.04	11.66
D		55.51	57.14	21.09	13.44	33.96	17.15
E		56.39	54.49	16.02	10.58	31.24	18.49
F		31.85	33.67	4.34	3.14	10.81	9.72
G		58.15	60.10	13.11	9.56	29.76	18.98
H		59.10	58.18	12.29	8.13	29.20	17.93
I		50.95	53.99	7.16	3.87	21.90	14.12
J		66.23	62.09	10.56	6.58	32.13	19.47
K		60.03	61.01	11.55	6.79	31.04	20.77
L		44.29	46.46	7.42	6.18	15.14	10.40

4 CONCLUSIONS

From the results it was found that the colour difference value of both methods differ significantly, but each method gave good performance to measure the colour difference. However, it should be noted that the RGB space model depends on the input, so the more accurate the digital image with the original sample, the value will be closer to the colour difference values of laboratory measurements. The colour measurement method using spectrophotometer and mathematical calculations from digital images can be used. However, these two methods cannot replace each other because RGB is very dependent on the input produced by the scanner.

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