

EFFECT OF TANNIN MORDANT ON SILK DYED WITH TROPICAL ALMOND LEAVES (*TERMINALIA CATAPPA* LINN.)

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ABSTRACT

The objectives of this research project were to study the color values and colorfastness to washing of silk fabric with dyed with Tropical Almond leaves. Four types of mordant at the concentration level of 5 percent were used: tannin distilled from Cassava leaves, copper sulphate, potassium dichromate, potassium aluminium sulphate and no mordant method was also studied. The result revealed that mordant types had an effect on color values at the significant level of 0.05. Tannin increased lightness (L^*). The study of colorfastness to washing was examined from total color difference (dE^*). The result revealed that mordant types had an effect on color change but did not have an effect on color staining at the significant level of 0.05. For Tannin, the dE^* of color change value was 3.28 (level 3-4 or good level) and the dE^* of color staining value was 0.90 (level 5 or superative level). It is therefore recommended that tannin can be used as mordant to further improve the quality of dyeing silk with natural dye.

Keywords : Tannin, Mordant, Silk, Color value and Colorfastness to Washing

INTRODUCTION

Color is a factor affected esthetic of textile. Natural color is used by human to dyes textile. Natural dyes are extracted from plants and some kinds of animals. A problems of natural dyes is the color quality in terms of colorfastness to washing because it can easily bleed and fade. [1],[2] Mordant is a substrate which is used to improve the color quality of natural dyes because mordant can be bonded with dyes molecule and fiber, called the color lake region that increases the colorfastness quality. [3] The mordant normally used to increase the color quality of natural dyes is a heavy metal compound such as copper sulphate, potassium dichromate and potassium aluminium sulphate. They can be harmful to consumers, textile producers and environment.

Tannin is a phenol compound with complex composition, in terms of size and shape of the molecule. Tannin is soluble in water and can cause chemical reactions between polyphenols in proteins. Tannins are a dye and a dye auxiliary agent for improving colorfastness. The use of tannin as mordant in dyeing silk with natural dyes catches a lot of interest in the

natural dyes to increase the durability of the color after washing and enhancing the quality of the natural dyed silk fabrics.

OBJECTIVES

The study basically consists of two main objectives as follows:

1. To study the color value of silk fabric dyed with natural color from Tropical Almond leaves and mordant with tannin extracted from cassava leaves, copper sulphate, potassium dichromate and potassium aluminium sulphate.
2. To study the colorfastness to laundering of silk fabric dyed with natural color from Tropical Almond leaves and mordant with tannin extracted from cassava leaves, copper sulphate, potassium dichromate and potassium aluminium sulphate.

Hypotheses

In order to evaluate the color value of dyed silk yarn (objective 1), the following hypotheses were tested:

1. There was no difference in L^* value among silk fabric dyed by the four kinds of mordant.
2. There was no difference in a^* value among silk fabric dyed by the four kinds of mordant.
3. There was no difference in b^* value among silk fabric dyed by the four kinds of mordant.
4. There was no difference in C^* value among silk fabric dyed by the four kinds of mordant.
5. There was no difference in h^* value among silk fabric dyed by the four kinds of mordant.

In order to evaluate the colorfastness of dyed silk fabric (objective 2), the following hypotheses were tested:

1. There was no difference in dL^* value among silk fabric dyed by the four kinds of mordant.
2. There was no difference in da^* value among silk fabric dyed by the four kinds of mordant.
3. There was no difference in db^* value among silk fabric dyed by the four kinds of mordant method.
4. There was no difference in dC^* value among silk fabric dyed by the four kinds of mordant.
5. There was no difference in dh^* value among silk fabric dyed by the four kinds of mordant.
6. There was no difference in dE^* value of the color change among silk fabric dyed by the four kinds of mordant.
7. There was no difference in dE^* value of the color staining among silk fabric dyed by the four kinds of mordant.

MATERIALS AND METHODS

Materials and Equipment

1. Silk fabric in plain weave structure. (from Jun Thai Silk Company)
2. Tropical Almond leaves planted at Kasetsart University.
3. Plain water for dye extract and dyeing process.
4. Four kinds of mordant which are Tannin extracted from cassava leaves from pilot plant of tannin extraction from agricultural waste project 1000 ppm., copper sulphate, potassium dichromate and potassium aluminium sulphate (5 % of dye solution was used).
5. LA-650 IR Infra-red dryer
6. KB8 burner (Seng Tai, diameter: 16 centimeters)
7. LPG (PTT Public Co., Ltd.)
8. Spectrophotometer Datacolor 650TM (Spectraflash 500 Xenon Flash Lamp, Diffuse/8)
9. Atlas Launder-Ometer DWGA 11-4579
10. 1993 AATCC Standard Reference Detergent WOB (without fluorescent whitening agent and without phosphate)
11. Multi-fiber test fabrics No.1 and FB (8 millimeter (0.33 inch) bands) containing bands of acetate, cotton, nylon, silk, viscose rayon and wool
12. Stainless steel lever lock canisters Type 1 500 milliliters (1 pt), 75 x 125 millimeters (3.0 x 5.0 inches)
13. Stainless steel balls, 6 millimeters (0.25 inch) in diameter
14. Teflon fluorocarbon gaskets
15. Thermometer
16. Scientific equipment such as beaker and stirring rod

Methods

1. Dye extraction

Tropical Almond leaves were extracted with water by using ratio 5:1 (v/w), boiled at temperature of 90°C for 40 minutes.

2. Dyeing sample

The dyeing experiment was conducted by using randomized complete design with 5 treatments and 3 replications. The 5 treatments were as follows:

Treatment 1: Dyeing silk fabric with Tropical Almond leaves and no mordant.

Treatment 2: Dyeing silk fabric with Tropical Almond leaves and after mordant with tannin extracted from cassava leaves from pilot plant of tannin extraction from agricultural waste project 1000 ppm. (5 % of solution was used).

Treatment 3: Dyeing silk fabric with Tropical Almond leaves and after mordant with copper sulphate (5 % of solution was used).

Treatment 4: Dyeing silk fabric with Tropical Almond leaves and after mordant with potassium dichromate (5 % of solution was used).

Treatment 5: Dyeing silk fabric with Tropical Almond leaves and after mordant with potassium aluminium sulphate (use 5 % of solution was used).

For the dyeing method, dye extracted solution in the ratio of 30:1 was used. It was boiled at the temperature of 90°C for 40 minutes. The dyed silk fabric was soaked in plain water. Then, after mordant in the ratio of 30:1 was used and the fabric was boiled at the temperature of 90°C for 40 minutes. Then the silk fabric was soaked in plain water until it was cleaned. After that, it was hung dry.

3. Colorfastness of silk fabric test

Samples of each replication were randomly selected and tested for the color values before and after washing for colorfastness to laundering according to the AATCC Standard Test Method 61-2005 Test No.1A. [4]

Fifty millimeters (2 inches) wide and 100 millimeters long (4 inches) fabric of each sample was prepared. The 50 millimeters multifiber test fabric was attached only along the upper 50 millimeters edge and on the top of the sample with the wool on the right. Each prepared specimen was washed at a temperature of 40°C for 45 minutes by using 0.37% detergent of total volume, total liquor volume 200 milliliters and 10 stainless steel balls.

4. The color values (L^* : lightness-darkness, a^* : red-green value, b^* : blue-yellow value, C^* : chroma and h^* : hue) were measured before and after laundering by using the spectrophotometer Datacolor 650TM of Data Expert Co., Ltd.

RESULTS AND DISCUSSION

According to the mentioned two objectives, the results related to the objectives can be illustrated as follows:

Table 1: *L*, a*, b*, C* and h* of the Tropical Almond leaves color silk fabric dyed by four different kinds of mordant and no mordant method.*

| Mordant | Color value | | | | |
|------------------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| | L* | a* | b* | C* | h* |
| No mordant (Control) | 59.96 _b | 3.76 _{cd} | 38.64 _b | 38.83 _b | 84.44 ^b |
| Tannin | | | | | 82.62 ^c |
| copper sulphate | 64.11 ^a | 4.29 ^c | 33.16 _c | 33.43 _c | 71.43 ^d |
| potassium dichromate | 34.84 _e | 7.14 ^b | 21.26 _e | 22.42 _e | 71.86 ^d |
| potassium aluminium sulphate | 39.39 _d | 9.03 ^a | 27.57 _d | 29.01 _d | 85.77 ^a |
| | 56.72 _c | | 44.47 _a | 44.60 _a | |

Note: The values (a, b, c, d, e) in each of the vertical column were not statistically different when compared.

The difference of the means by DMRT method was different at the significant level of 0.05.

For the L* values, the tannin mordant method produced lighter color of dyed silk fabric as seen from the higher L* values, implying that other types of mordant yielded darker color in silk fabric.

In terms of the a* values which is the degree of red-green value, the tannin mordant method produced redder color of dyed silk fabric as seen from the plus a* values. However, the value is lower than those of potassium dichromate and copper sulphate.

In terms of the b* values implying the degree of yellow-blue value, the potassium aluminium sulphate mordant method produced yellower color of dyed silk fabric as seen from the higher b* values but tannin, potassium dichromate and copper sulphate produced bluer color of dyed silk fabric respectively.

In terms of the C* values which implied the degree of color purity or degree of chroma, the tannin mordant method produced a little duller color of dyed silk fabric than no mordant method.

In terms of the h* values implying the quality of color name, the quality of dyed silk fabric from the five methods were between 71-86° implying that all methods could produce the same angle range of yellow.

Table 2 Analysis of variance of L^* , a^* , b^* , C^* and h^* values of the Tropical Almond leaves color silk fabric dyed by four different methods of mordant.

| Color value | Source of Variation | df | SS | MS | F |
|-------------|---------------------|----|---------|---------|----------|
| L^* | Treatment | 4 | 514.344 | 128.586 | 401.338* |
| | Error | 10 | 3.204 | .320 | |
| | Total | 14 | 517.548 | | |
| a^* | Treatment | 4 | 29.272 | 7.318 | 146.221* |
| | Error | 10 | .500 | .050 | |
| | Total | 14 | 29.772 | | |
| b^* | Treatment | 4 | 258.561 | 66.039 | 233.750* |
| | Error | 10 | 2.619 | .283 | |
| | Total | 14 | 261.180 | | |
| C^* | Treatment | 4 | 264.156 | 66.039 | 233.750* |
| | Error | 10 | 2.825 | .283 | |
| | Total | 14 | 266.981 | | |
| h^* | Treatment | 4 | 113.650 | 28.412 | 163.634* |
| | Error | 10 | 1.736 | .174 | |
| | Total | 14 | 115.386 | | |

* Significant at .05 level

The result of the analysis of variance of L^* , a^* , b^* , C^* and h^* values of four treatments indicated that L^* , a^* , b^* , C^* and h^* values were significantly different at 0.05 level implying that the four alternative methods affected the L^* , a^* , b^* , C^* and h^* value.

Table 3 *dE** values of color change, color staining and colorfastness to laundering level of the silk fabric dyed by four different mordant methods.

| Mordant | dE* of color change | | | dE* of color staining | | |
|------------------------------|---------------------|-------|-------------|-----------------------|-------|-------------|
| | dE* | grade | quality | dE* | grade | quality |
| No mordant | 10.68 _b | 1-2 | poor | 1.09 | 5 | Superlative |
| Tannin | 3.28 ^c | 3-4 | good | 0.90 | 5 | Superlative |
| copper sulphate | 2.34 ^c | 4 | Excellent | 1.05 | 5 | Superlative |
| potassium dichromate | 2.20 ^d | 4 | Excellent | 1.08 | 5 | Superlative |
| potassium aluminium sulphate | 4.87 ^a | 2-3 | Fairly good | 0.87 | 5 | Superlative |

Note: The values (a, b, c, d, e) in each of the vertical column were not statistically different when compared.

The difference of the means by DMRT method was different at the significant level of 0.05.

Color change from laundering dyed silk fabric as expressed by dE* values indicated an inconsistency of dyeing quality among different dyeing methods. The results of color change revealed that mordant types were significantly different, but the color staining was not significantly different at .05 level. The no mordant method showed the lower quality of dyed silk revealing in the lowest dE* values (10.68) of color change. For tannin, the dE* of color change value was 3.28 (level 3-4, good level) and was in the same group of copper sulphate when categorized by Duncan's grouping.

The dE* values of color staining were at the same time found quite in the low level, implying that there were high color stains on white test cloth. All of the samples produced high colorfastness in terms of color staining. The dE* of color staining value of tannin mordant method was 0.90 (level 5, superative level).

Table 4 Analysis of variance of dE* values of color change of the Tropical Almond leaves color silk fabric dyed by five different mordant methods.

| Color value | Source of Variation | df | SS | MS | F |
|-------------|---------------------|----|---------|---------|----------|
| dE* | Treatment | 4 | 514.344 | 128.586 | 401.338* |
| | Error | 10 | 3.204 | .320 | |
| | Total | 14 | 517.548 | | |

* Significant at .05 level

The result of the analysis of variance of dE* values of color change of five treatments indicated that dE* values of color change were significantly different at .05 level, implying that the four methods affected the dE* value of color change.

CONCLUSION

The tannin after mordant method produced the yellow color and increased the more lightness (L*) than copper sulphate, potassium dichromate and potassium aluminium sulphate in after mordant method. The study of colorfastness to washing was examined from total color difference (dE*). The results revealed that the dE* of color change value of tannin as after mordant method was in the same group of copper sulphate.

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