Exploration source of natural dyes for batik from fresh and fallen leaves

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Abstract. The use of synthetic dyes can cause health and environmental problems. Therefore it is necessary to explore various potential sources of natural dyes from fresh and fallen leaves of various plants. This study aimed to examine the influence of plant various and leaves types to the brightness color (L) and various color (a value and b value) of color produced on various fixation materials. Natural dyes were extracted using a heating method with a water solvent. Natural dye sources were taken from glodogan tiang (Polyathea longifolia) leaves, teak (Tectona grandis L. F) leaves, angsana (Pterocarpus indicus) leaves, and mango (Mangifera indica) leaves. The types of leaves were fresh and fallen leaves. Furthermore the natural dye was immersed in a cotton cloth and fixed using materials fixation, namely: alum, lime and tunjung. Test on dyeing cloth used color difference test (L * a * b). The results of the study shown that bright colors were produced from fallen leaves with alum fixation material. The colors of the fabric produced generally tend to be yellow and red.

1. Introduction

Batik is an original work of art belonging to the Indonesian people that needs to be preserved. Batik’s color is one of the determining factors the quality of batik that affect in the consumer's decision to buy the product [1]. All the time, the process of coloring batik using synthetic dyes, which are not environmentally friendly. The use of synthetic dyes for a long time, will have an impact on environmental damage and health because they contain heavy metal pollutants. Waste of synthetic dyes can degrade to forming products that are highly toxic and carcinogenic [2]. Therefore, it is necessary to attempt extracting natural dyes for batik dyeing process.

The use of natural dyes besides being environmentally friendly, also produces more beautiful colors as the color transfers and fades [3]. Natural dyes are also in demand by consumers [4], because natural dyes can apply for many purposes, such as coloring fibers wool, cotton, and silk as well as fur and leather [5], as well as in food, cosmetics, and pharmaceuticals [6]. In addition, many natural dye sources in Indonesia are available with an easier extraction process [7]. According to Rosyida and Achadi [8] and Mohini et al. [9], natural dyes plants are one of the natural resources that have the potential to be used as textile coloring agents in Indonesia, especially in product development nuanced naturalist, amative, culturist and exclusive and can be the raw material of textile industry which has high economic value.
2. Materials and Methods

2.1. Materials

The materials used in the study were as natural coloring sources, namely fresh or fallen leaves of glodogan tiang (Polyalthia longifolia), teak (Tectona grandis L. F), angsa (Pterocarpus indicus), and mango (Mangifera indica). Cotton cloth and water as extraction solvent. Fixation materials used were alum (Al₃(SO₄)₃), lime (CaCO₃) and tunjung (FeSO₄).

2.2. Methods

The study design used a randomized block design consisting of two factors. The first factor was the many kind of plants (S) consisting of glodogan tiang, teak, angsa and mango plants. The second factor was the types of leaf (L) which consists of fresh and fallen leaves. Each treatment was repeated three times. Natural dyes were obtained from fresh and fallen leaves of glodogan tiang, teak, angsa and mango plants. The leaves were extracted by heating at a temperature of 100°C or until boiling. The solution obtained was applied to the coloring of batik on cotton fabric by repeated dyeing. Furthermore, the cloth was locked using lime, alum and tunjung fixation materials. It is intended to maintain color so it does not fade easily.

2.3. Observation and data analysis

After coloring the cloth will be observed using a "color reader" (color reading). The most important color classification determination is to use the CIE system (International Commission de l’éclairage). The other systems used to describe colors include the Munsell, Hunter, and Lovibond systems. The Hunter system is one of the most widely used color systems. In the hunter system, colors are divided into three color dimensions. Symbol a for reddish and greenish dimension, symbol b for yellowish and bluish dimensions, while symbol L (lightness) for brightness [1].

The parameters observed in this research were brightness, a value and b value. In addition, fabric that has been fixed is also observed using a 'color reader' (color reading). The parameters observed are brightness (L), a value and b value. The brightness value is L with a range value of 0-100. A value of 0 is equal to black, while up to 100 is equal to white. A high L value means that the more bright or the lower the L value the darker. Value of a leads to red or green. A positive (+) tends towards red and negative values (-) tend towards green. Value of b leads to yellow or blue. The positive b (+) tends to be yellow and the negative b (-) tends to be blue [1].
The data obtained were analysed by variance analysis. If there was a real difference followed by Duncan’s Test at the confidence level of 95 percent.

3. Results and Discussion

3.1. Brightness value

The average data of the brightness value of the natural dyeing results on batik cloth after fixation with alum was shown in Table 1. Based on variance analysis there was an interaction between the treatment of plant sources and types of leaves. These shown that plant sources and species significantly influence the brightness value of natural dyes produced after fixation using alum.

| Factor | L1 (Fresh leaves) | L2 (Fallen leaves) |
|--------|-------------------|--------------------|
| S1 (Glodogan tiang) | 76.9<sup>a</sup> | 84.2<sup>f</sup> |
| S2 (Teak) | 78.6<sup>b</sup> | 79.9<sup>e</sup> |
| S3 (Angsana) | 83.3<sup>c</sup> | 82.1<sup>d</sup> |
| S4 (Mango) | 78.5<sup>b</sup> | 83.2<sup>e</sup> |

Note: different letters indicate a significant difference between treatments at 95% confidence level

The average data of the brightness value of the natural coloring results on batik cloth after fixation with lime was shown in Table 2. Based on variance analysis there was an interaction between the treatment of plant sources and types of leaves. These shown that plant sources and species significantly influence the brightness value of natural dyes produced after the fixation process with lime.

| Factor | L1 (Fresh leaves) | L2 (Fallen leaves) |
|--------|-------------------|--------------------|
| S1 (Glodogan tiang) | 78.5<sup>d</sup> | 84.9<sup>f</sup> |
| S2 (Teak) | 74.7<sup>a</sup> | 77.7<sup>c</sup> |
| S3 (Angsana) | 81.8<sup>e</sup> | 82.1<sup>c</sup> |
| S4 (Mango) | 78.6<sup>d</sup> | 75.7<sup>b</sup> |

Note: different letters indicate a significant difference between treatments at 95% confidence level

The average data of the brightness value of the natural coloring results on batik cloth after fixation with tunjung was shown in Table 3. Based on variance analysis there was an interaction between the treatment of plant sources and types of leaves. These shown that the source of the plant and its type together significantly influence the brightness value of the natural dyes produced after the process of fusing using tunjung.
Table 3. Average brightness value natural dyes of batik (with tunjung).

| Factors                  | L1 (Fresh leaves) | L2 (Fallen leaves) |
|--------------------------|-------------------|--------------------|
| S1 (Glodogan tiang)      | 69.6<sup>cd</sup> | 77.2<sup>1</sup>   |
| S2 (Teak)                | 63.6<sup>a</sup>  | 70.4<sup>d</sup>   |
| S3 (Angsana)             | 75.8<sup>ef</sup> | 75.1<sup>e</sup>   |
| S4 (Mango)               | 69.2<sup>c</sup>  | 66.6<sup>b</sup>   |

Note: different letters indicate a significant difference between treatments at 95% confidence level.

Based on Tables 1, 2, and 3, it appears that in general the L value of fallen leaves was higher than fresh leaves. A higher L value indicates that fallen leaves producing brighter colors than fresh leaves (Table 4). Fresh leaves of glodogan tiang, teak, angsana and mango are green while the deciduous leaves are yellow to brownish yellow. This is because the anthocyanin content in fallen leaves tends to be higher than fresh leaves. During the leaf aging process, chlorophyll in the form of green dyes will be degraded so that the yellow color appears from anthocyanin.

Table 4. Comparison of L values produced between fresh and fallen leaves.

| Various of plants        | Fresh leaves | Fallen leaves |
|--------------------------|--------------|---------------|
| Glodogan tiang <br> (*Polyathea longifolia*) | L = 76.9     | L = 84.2      |
| Angsana <br> (*Pterocarpus indicus*)           | L = 83.3     | L = 84.2      |

Based on Table 4, it can be seen that the color of the fabric produced from the leaves of various types of plants has an L value or a brightness level that was significantly different. This is because each type of leaf has different types of dyes with different concentrations.

The material used in the fixation process also affects the brightness of color. Based on Tables 1, 2 and 3, it can be seen that alum fixation materials tend to produce higher L value (brighter) followed by lime and tunjung fixation materials (darker). L value on the fabric fixation produced can be seen in Table 5. This is in accordance with the opinion [14], which states that alum fixation materials produce colors that tend to be brighter, while tunjung produces colors that tend to be darker. According to Pujilestari [1], the presence of Fe<sup>2+</sup> ions on tunjung (ferrous sulfate) reacts with high-molecular dyes in the fibers to form a larger bond.
Table 5. Comparison of L values for various types of fixation materials.

| Types of leaf                              | Fixation materials |   |   |
|-------------------------------------------|--------------------|---|---|
|                                            | Alum               | Lime | Tunjung |
| Fresh leaves of glodogan tiang (Polyadeca longifolia) |                     | L = 76.9 | L = 78.5 | L = 69.6 |
| Fallen leaves of glodogan tiang (Polyadeca longifolia) |                     | L = 84.2 | L = 84.9 | L = 77.2 |

3.2. Value of a and b

The average data a and b value of the results of natural coloring on batik after fixation with alum was shown in Table 6. Based on variance analysis there was an interaction between the treatment of plant sources and types of leaves. These shown that the source of the plant and its species together significantly influence the value of a natural dye produced after the fixation process using alum.

Table 6. Average a and b value of batik natural color (with alum).

| Factors                                      | a Value |   |   |
|----------------------------------------------|---------|---|---|
|                                              | L1 (Fresh leaves) | L2 (Fallen leaves) | L1 (Fresh leaves) | L2 (Fallen leaves) |
| S1 (Glodogan tiang)                         | 8.0<sup>a</sup> | 2.1<sup>b</sup> | 9.4<sup>c</sup> | 3.8<sup>a</sup> |
| S2 (Teak)                                   | -3.3<sup>a</sup> | 4.6<sup>c</sup> | 16.0<sup>e</sup> | 14.8<sup>d</sup> |
| S3 (Angsana)                                | 2.2<sup>b</sup> | 2.8<sup>c</sup> | 6.5<sup>b</sup> | 9.1<sup>c</sup> |
| S4 (Mango)                                  | 2.9<sup>d</sup> | -3.3<sup>a</sup> | 16.3<sup>c</sup> | 34.3<sup>f</sup> |

Note: different letters indicate a significant difference between treatments at 95% confidence level

The average data a value and b value of the results of natural coloring on batik cloth after fixation with lime was shown in Table 7. Based on variance analysis there was an interaction between the treatment of plant sources and types of leaves. These shown that the source of the plant and its species together significantly influence the value of a natural dye produced after the fixation process with lime.

Table 7. Average a and b value of batik natural color (with lime).

| Factors                                      | a Value |   |   |
|----------------------------------------------|---------|---|---|
|                                              | L1 (Fresh leaves) | L2 (Fallen leaves) | L1 (Fresh leaves) | L2 (Fallen leaves) |
| S1 (Glodogan tiang)                         | 8.1<sup>d</sup> | 6.3<sup>c</sup> | 14.8<sup>d</sup> | 2.7<sup>a</sup> |
| S2 (Teak)                                   | 5.8<sup>c</sup> | 6.1<sup>c</sup> | 20.6<sup>d</sup> | 17.1<sup>e</sup> |
| S3 (Angsana)                                | 3.4<sup>a</sup> | 2.8<sup>a</sup> | 11.3<sup>c</sup> | 9.1<sup>b</sup> |
| S4 (Mango)                                  | 4.1<sup>b</sup> | 4.6<sup>b</sup> | 18.5<sup>c</sup> | 36.9<sup>f</sup> |

Note: different letters indicate a significant difference between treatments at 95% confidence level
The average data a value and b value of the results of natural coloring on batik cloth after fixation with tunjung was shown in Table 8. Based on variance analysis there was an interaction between the treatment of plant sources and types of leaves. These shown that the source of the plant and its species together significantly influence the value of a natural dye produced after the fixation process using tunjung.

Table 8. Average a and b value of batik natural color (with tunjung).

| Factor       | a Value | b Value |
|--------------|---------|---------|
|              | L1      | L2      | L1      | L2      |
|              | (Fresh leaves) | (Fallen leaves) | (Fresh leaves) | (Fallen leaves) |
| S1 (Glodogan tiang) | 6.0<sup>a</sup> | 4.4<sup>bc</sup> | 16.3<sup>a</sup> | 20.8<sup>d</sup> |
| S2 (Teak)    | 4.1<sup>a</sup> | 5.0<sup>ed</sup> | 15.7<sup>a</sup> | 19.2<sup>c</sup> |
| S3 (Angsana) | 4.1<sup>ab</sup> | 5.4<sup>d</sup> | 19.8<sup>ed</sup> | 22.4<sup>e</sup> |
| S4 (Mango)   | 4.5<sup>bed</sup> | 3.8<sup>a</sup> | 22.1<sup>e</sup> | 17.6<sup>b</sup> |

Note: different letters indicate a significant difference between treatments at 95% confidence level.

Based on the results of measurements of a value and b value indicate that on all types of plants and types of leaves tend towards red and yellow. This is in line with the opinion [15], that the source of natural dyes generally produces yellow. However the fresh teak leaves and fallen mango leaves tend towards the yellow green as shown Table 9.

Table 9. Comparison of values of a and b produced between fresh and fallen leaves.

| Various of plants | Fresh leaves | Fallen leaves |
|-------------------|--------------|---------------|
| Teak (Tectona grandis L.F.) | a = -3.3 | a = 4.6 |
|                   | b = 16.0 | b = 14.8 |
| Mango (Mangifera indica) | a = 2.9 | a = -3.3 |
|                   | b = 16.3 | b = 34.3 |

4. Conclusions
The brightness value of the colors produced from the coloring process of batik made from natural dyes, namely fresh leaves and fallen leaves from various plants were significantly different. Fresh leaves produced an L value that tends to be smaller than fallen leaves. Similarly, the used of different fixation materials produced different brightness values. Among fixation materials of alum, lime and tunjung, the brightest brightness value (high L value) was produced by alum fixation material. The results of measuring a value and b value on various plants and leaf types indicated that the color of the fabric produced tends to be red and yellow. However the used of coloring sources of fresh leaves of and fallen leaves of mango resulting in the color of the fabric tends towards green and yellow.
Acknowledgement
This research was funded by the Ministry of Research, Technology and Higher Education of the Republic of Indonesia through a Higher Education Applied Research Grant with contract numbers 008/SP2H/LT/K7/KM/2018.

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