Preliminary study of natural dyes application on batik

by Tri Rahayuningsih

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Abstract. Batik is an Indonesia cultural heritage. In general, batik dyeing uses synthetic dyes, which can cause problems in health and the environment. Therefore, the exploration of natural dyes is needed to apply to batik. This study aimed to determine the quality of batik used natural dyes based on the types of plants and the types of leaves. Natural dyes were extracted using a heating method with a water solvent. Natural dye sources took from *glodogan tiang* (*Polyathea longifolia*), teak (*Tectona grandis* L. F), *angsana* (*Pterocarpus indicus*), and mango (*Mangifera indica*) leaves. The types of leaves were fresh and fallen leaves. The natural dyes applied as a dye of batik with *tunjung* fixation material. Test on the result of batik dyeing used the color difference test (L * a * b) and consumer preference test with parameters of color intensity, batik neatness, and clarity on batik motif. Determining the importance level of the batik quality parameters used the Analytical Hierarchy Process method. Then the selection of the best treatment alternative was made using the Expectation Value method. The results of the study shown that the best treatment was batik with natural dyes from fallen leaves of teak. That caused dye of teak fallen leaves can bound more tightly than other leaves.

1. Introduction

Batik is known to the world as the original work of the Indonesian that needs to be preserved. The color of batik as one aspect that affects consumers to buy [1]. Batik craftsmen/traditional dyers generally use synthetic dyes, because the colors produced are strong, stable and easily obtained. But unfortunately the synthetic dyes 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.

Natural dye is a choice because it is an environmentally friendly dye. In addition, natural dyes produce softer colors that have a special appeal, so they give an exotic and beauty impression [3]. According to Gulrajani [4], the use of natural dyes has increased substantially. These dyes are being mainly used by hobby groups, designers, traditional dyers, non-government organizations, museums, academic institutes, research associations, and industries.

Plants are often used as a source of natural dyes [5]. Meanwhile, Indonesia is a fertile country with huge availability of plants. This is a chance to grow Indonesian economic potential that must be developed in relation to natural coloring sources. One process of making batik is a fixation process that aims to bind colors so that the coloring results are not easily faded. This fixation process uses a material called fixer. The fixation process in principle is to condition the dye that has been absorbed at a certain time so that a

reaction occurs between the colored material, and the dyes and materials that will be used for fixation. There are several fixation materials that are often used including lime ($CaCO_3$), alum ($Al_2(SO_4)_3$), and *tunjung* ($FeSO_4$) [6]. The use of different types of fixers will produce different colors [7]. According to Pujilestari [6], fixation can function to strengthen colors and change natural dyes according to the type of metal that binds them and locks the dyes that have entered the fiber. According to (Pujilestari) [1], the presence of Fe^{+2} ions on *tunjung* (*ferrous sulfate*) reacts with high-molecular dyes in the fibers to form a larger bond.

According to Rahayuningsih et al. [8], *tunjung* is a fixer that is able to provide stronger color results in batik. Therefore, in this study natural dyes derived from fresh leaves and fallen leaves was applied for making batik with *tunjung*. The purpose of this study was to determine whether sources of natural dyes from fresh and fallen leaves of various plants can be used for batik.

2. Materials and Method

2.1. Materials

The materials used in the study were as natural coloring sources, namely fresh or fallen leaves of *glodogan tiang* (*Polyathea longifolia*), *teak* (*Tectona grandis* L. F), *angsana* (*Pterocarpus indicus*), and mango (*Mangifera indic*a), cotton cloth, and water as extraction solvent. Fixation materials used was *tunjung* ($FeSO_4$). The Fresh and fallen leaves were collected from Sidoarjo, and for preparation the leaves were cut before extracting.

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*, mango, *angsana* and *teak* plants. The second factor was the types of leaves (L) which consists of fresh and fallen leaves. Each treatment was repeated three times. The leaves were extracted by hot method with heating at a temperature of 100^{o}C. Extraction ratio between material and water were 1:10. Boiling process took place until leaving extraction half of the previous volume of water [9]. The solution obtained was applied to the coloring of batik on cotton fabric by repeated dyeing. Furthermore, the cloth was locked tunjung fixation material. It is intended to maintain color so it does not fade easily.

2.3. Observation and data analysis

After batik dyeing will be observed using a "color reader" (color reading). The most important color classification determination is to use the CIE system (International Commission de I'eclairage). 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. The high L value means that the color brighter or the lower the L value the darker. Value of a leads to red or green. The a value 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.

Besides that, for other parameters observed were tests of consumer preferences for batik products focussed on color intensity, neatness of batik and motif clarity of batik. For determining the weight of interests of batik quality assessment parameter used the Analytical Hierarchy Process [10]. AHP was done by brainstorming with batik experts who knew the most important parameters of batik. Then to choose the best treatment was used alternatives chosen with Expectation Value Method [11]. The basis for calculating the best treatment selection is product quality for each parameter and the importance weights of each of

these parameters. The parameters used in the consumer preference test were color intensity, neatness and motif clarity. The best treatment depended on the maximum expected value.

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 *tunjung* 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 *tunjung*. Natural dyes obtained from plants produce very diverse colors depending on the type and part of the plant and how to obtain it [12]. According to Lestari and Satria [13] the smaller brightness value indicated more colored cloth, so more colors appeared.

Table 1. Average brightness value natural dyes of batik

Factors	L1 (Fresh leaves)	L2 (Fallen leaves)
S1 (*Glodogan tiang*)	69.7^{c}	77.4^{b}
S2 (Mango)	59.8^{a}	73.7^{d}
S3 (*Angsana*)	73.8^{d}	73.4^{d}
S4 (Teak)	70.7^{c}	63.0^{b}

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

Based on Tables 1, 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 2), except fallen leaves of teak. According to Pujilestari [14], chlorophyll is unstable dye, so it is easy to change. The fallen leaves had undergone changes in chemical components. So that it was possible the chlorophyll content has been reduced.

Table 2. Comparison of L values produced between fresh and fallen leaves

Various of plants	Fresh leaves	Fallen leaves
Glodogan Tiang (*Polyathea longifolia*)		
Mango (*Mangifera indica*)		
Angsana (*Pterocarpus indicus*)		
Teak (*Tectona grandis* L. F)		

3.2. a value

The average data of a value of the natural dyeing results on batik cloth after fixation with *tunjung* was shown in Table 3. Based on variance analysis there was no an interaction between the treatment of plant sources and types of leaves. These shown that plant sources significantly influence a value. Moreover, it shown that fresh and fallen leaves have the same impact for a value. Based on Duncan's test, teak and mango produced the same value as well as *angsana* and *glodogan tiang* leaves. The higher a value, the color tend to be yellow [1].

Table 3. Average a value from Duncan test

Factors	a Value
S4 (Teak)	4.95[a]
S2 (Mango)	5.10[a]
S3 (*Angsana*)	5.81[b]
S1 (*Glodogan tiang*)	5.93[b]

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

3.3. b value

The average data of b value of the natural dyeing results on batik cloth after fixation with *tunjung* was shown in Table 4. 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 b value of natural dyes produced after fixation using *tunjung*. The positive parameter b value produced yellow [1]. Natural dyes from fallen leaves produced a more yellow color than fresh leaves.

Table 4. Average b Value natural dyes of batik

Factors	L1 (Fresh leaves)	L2 (Fallen leaves)
S1 (*Glodogan tiang*)	8.8[b]	15.4[e]
S2 (Mango)	7.5[a]	13.7[d]
S3 (*Angsana*)	13.1[d]	13.8[d]
S4 (Teak)	11.0[c]	10.7[c]

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

3.4. Consumer preference test

The percentage of panellists who stated they were very like and much more very like of batik from all treatment were presented in the following Table 5. Based on Table 5 showed that panellist tend to choose batik with natural dyes of *teak* fallen leaves (S4L2). Panellist preferred color intensity of S4L2 because fallen leaves of *teak* had a small L value, so it can bound tightly on batik. According to Lestari and Satria [13] a smaller L value produced a tightly colored cloth. Thus, it made the color intensity more appear than other treatments. Besides that, S4L2 obtained batik neatness most likely caused dyes of fallen leaves *teak* not easy to seep out. This character affected the neatness of the batik produced. The combination of strong color intensity and neatness produces clear batik motifs. Therefore, 100% of panellists prefer S4L2.

Table 5. Result of consumer preferences test (%)

Parameters	S1L1	S1L2	S2L1	S2L2	S3L1	S3L2	S4L1	S4L2
Color Intensity	0	20.5	79.5	20.5	25.6	53.8	46.2	79.4
Neatness	0	23.1	0	23.1	41	20.5	23.1	76.9
Motif Clarity	0	17.9	64.1	0	35.9	0	0	100

3.5. Chosen alternatives

The results of analytical hierarchy process (AHP) values shown in Figure 1. That showed that motif clearly of batik has the highest importance weight, followed by color intensity, color brightness (L) and neatness. In every region in Indonesia has a variety of batik motifs. Generally, batik consumers decided to buy batik based on the motif. This was consistent with the results of research showing that batik motif clearly had the highest importance weight (47%). Afterward, consumers in choosing batik influenced by color intensity (28%), brightness (16%) and neatness (10%).

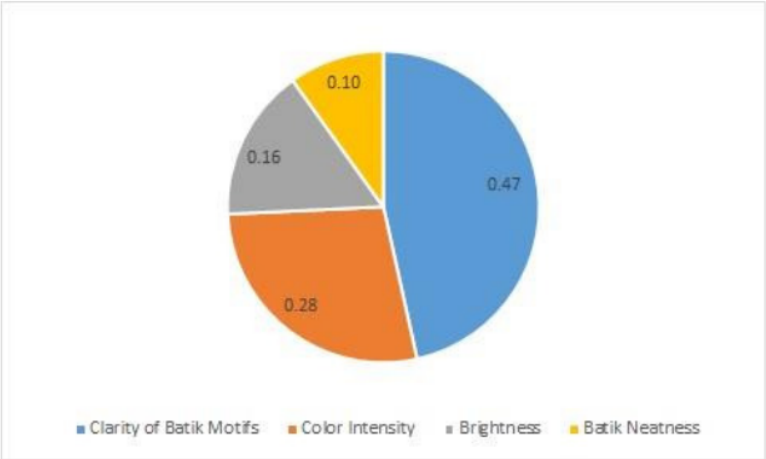

Figure 1. Importance weight of parameters based on AHP

3.6. Expectation Value

The highest expectation value is in the S4L2 treatment (9.7), which was the natural coloring source of fallen teak leaves. The expected value of each treatment shown in Figure 2 below. Based on the importance weight of each assessment parameter (motif clarity, color intensity, brightness, and neatness) S4L2 produced the best assessment compared to other treatments. The parameter values of motif clarity, color intensity, and neatness based on preference tests while the brightness parameter values based on L values. Based on the measurement of L values, S4L2 treatment produced the second-rate L value (Table 1). However, based on consumer preferences, as fact S4L2 was the best. Thus, based on the overall assessment S4L2 was the best treatment that had the highest Expectation Value.

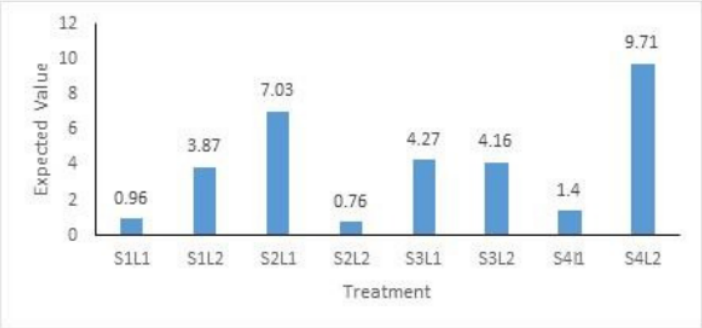

Figure 2. The expectation value of all treatments

4. Conclusions

The brightness of the natural color of batik was influenced by the interaction between plant types and leaf properties significantly. While the type of plant only significantly influenced the value of the natural color. That means that the fallen leaves did not affect the value of a. Whereas the value of b influence by the type of plant and the types of leaves. Based on the consumer preference test, the panellists preferred the S4L2 treatment in line with the highest Expectation Value, where the best treatment was batik made from the source of fallen teak leaves.

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