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

by Fungki Sri Rejeki

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

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

T Rahayuningsih[1,*], F S Rejeki[1], E R Wedowati[1] and D Widhowati[2]

[1] Agro-Industrial Technology, Faculty of Engineering, Universitas Wijaya Kusuma Surabaya, Surabaya, Indonesia
[2]Veterinary Medicine, Universitas Wijaya Kusuma Surabaya, Surabaya, Indonesia

E-mail: t_rahayu66@yahoo.co.id

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. Batiks' 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.

The use of natural dyes has several obstacles, including the coloring process that must be repeated, the limitations of color variations and unavailability on the market. Research on natural dyes for textiles has been carried out by Lestari and Satria [7] on angsana bark; Uddin [10] on mango leaves; and Fathinatullabibah et al [11] on teak leaf extract. Those study used natural dyes extracted from fresh leaves. The use of fresh leaves as a source of natural dyes will disrupt plant growth, so it is necessary to study the use of fallen leaves that are of no economic value.

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 ($FeSO_4$) [12]. The use of different types of fixers will produce different colors [13]. According to Pujilestari [12], 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.

This study examined various types of sources of natural dyes in the form of fresh and fallen leaves of various types of plants, namely: glodogan tiang, teak, angsana and mango; and the use of various types of fixation materials. While the purpose of this study was to determine the influence of plant species and leaf type on brightness (L) and type of color (a value and b value) produced on various types of fixation materials.

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 (*Polyathea longifolia*), teak (*Tectona grandis* L. F), angsana (*Pterocarpus indicus*) , and mango (*Mangifera indica*). Cotton cloth and water as extraction solvent. Fixation materials used were alum ($Al_2(SO_4)_3$), lime ($CaCO_3$) and tunjung ($FeSO_4$).

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, angsana 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, angsana and mango plants. The leaves were extracted by heating at a temperature of 100^0 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'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 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.

Table 1. Average brightness value natural dyes of batik (with alum).

Factors	L1 (Fresh leaves)	L2 (Fallen leaves)
S1 (Glodogan tiang)	76.9[a]	84.2[f]
S2 (Teak)	78.6[b]	79.9[c]
S3 (Angsana)	83.3[e]	82.1[d]
S4 (Mango)	78.5[b]	83.2[e]

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.

Table 2. Average brightness value natural dyes of batik (with lime).

Factors	L1 (Fresh leaves)	L2 (Fallen leaves)
S1 (Glodogan tiang)	78.5[d]	84.9[f]
S2 (Teak)	74.7[a]	77.7[c]
S3 (Angsana)	81.8[e]	82.1[e]
S4 (Mango)	78.6[d]	75.7[b]

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^{cd}	77.2^{f}
S2 (Teak)	63.6^{a}	70.4^{d}
S3 (Angsana)	75.8^{ef}	75.1^{e}
S4 (Mango)	69.2^{c}	66.6^{b}

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 (*Polyathea longifolia*)		
	L = 76.9	L = 84.2
Angsana (*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^{+2} 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 (*Polyathea longifolia*)	 L = 76.9	 L = 78.5	 L = 69.6
Fallen leaves of glodogan tiang (*Polyathea longifolia*)	 L = 84.2	 L = 84.9	 L = 77.2

3.2. Value of a and b

The average data a value 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		b Value	
	L1 (Fresh leaves)	L2 (Fallen leaves)	L1 (Fresh leaves)	L2 (Fallen leaves)
S1 (Glodogan tiang)	8.0^{f}	2.1^{b}	9.4^{c}	3.8^{a}
S2 (Teak)	-3.3^{a}	4.6^{e}	16.0^{e}	14.8^{d}
S3 (Angsana)	2.2^{b}	2.8^{c}	6.5^{b}	9.1^{c}
S4 (Mango)	2.9^{d}	-3.3^{a}	16.3^{e}	34.3^{f}

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		b Value	
	L1 (Fresh leaves)	L2 (Fallen leaves)	L1 (Fresh leaves)	L2 (Fallen leaves)
S1 (Glodogan tiang)	8.1^{d}	6.3^{c}	14.8^{d}	2.7^{a}
S2 (Teak)	5.8^{c}	6.1^{c}	20.6^{f}	17.1^{e}
S3 (Angsana)	3.4^{a}	2.8^{a}	11.3^{c}	9.1^{b}
S4 (Mango)	4.1^{b}	4.6^{b}	18.5^{e}	36.9^{g}

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 (Fresh leaves)	L2 (Fallen leaves)	L1 (Fresh leaves)	L2 (Fallen leaves)
S1 (Glodogan tiang)	6.0^{e}	4.4^{bc}	16.3^{a}	20.8^{d}
S2 (Teak)	4.1^{a}	5.0^{cd}	15.7^{a}	19.2^{c}
S3 (Angsana)	4.1^{ab}	5.4^{d}	19.8^{cd}	22.4^{e}
S4 (Mango)	4.5^{bcd}	3.8^{a}	22.1^{e}	17.6^{b}

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 b = 16.0	 a = 4.6 b = 14.8
Mango (*Mangifera indica*)	 a = 2.9 b = 16.3	 a = -3.3 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.

References

[1] Pujilestari T 2017 Batik fabric dyeing process optimization using natural dyes tingi (*Ceriops tagal*) and *Indigofera sp*. *Dinamika Kerajinan dan Batik* **34** 1 53–62. [In Indonesian]
[2] Ratna, Padhi B 2012 Pollution due to synthetic dyes toxicity & carcinogenicity studies and remediation *Int*. *J*. *Environ*. *Sci*. **3** 3 940–955.
[3] Mayusoh C 2015 The art of designing, fabric pattern by tie-dyeing with natural dyes *Procedia - Soc*. *Behav*. *Sci*. **197** 1472–1480.
[4] Degani L, Gulmini M, Piccablotto G, Iacomussi P, Gastaldi D, Dal Bello F, Chiantore O 2017 Stability of natural dyes under light emitting diode lamps *J*. *Cult*. *Herit*. **26** 12–21
[5] Cristea D, Vilarem G 2006 Improving light fastness of natural dyes on cotton yarn *Dye*. *Pigment*. **70** 3 238–245.
[6] Wahyuningsih S, Ramelan A H, Wardani D K, Aini F N, Sari P L, Tamtama B P N, Kristiawan Y R 2017 Indigo dye derived from indigofera tinctoria as natural food colorant *IOP Conf*. *Ser*. *Mater*. *Sci*. *Eng*. **193** 1 6–11,
[7] Lestari D W, Satria Y 2017 Utilization of angsana (*Pterocarpus indicus*) bark as source of natural dye in dyeing of silk batik *Dinamika Kerajinan dan Batik* **34** 1 35–42, [In Indonesian]
[8] Rosyida A, Achadi D 2014 Utilization of teak leaves for dyeing on cotton fabric at room temperature *Arena Tekst*. **29** 2 115–124. [In Indonesian]
[9] Mohini K, Tejashree L, Vijay N 2018 Dataset on analysis of dyeing property of natural dye from Thespesia populnea bark on different fabrics *Data Br*. **16** 401–410.
[10] Uddin M G 2015 Extraction of eco-friendly natural dyes from mango leaves and their application on silk fabric *Text*. *Cloth*. *Sustain*. **1** 7 1-8.
[11] Fathinatullabibah, Kawiji, Khasanah L U 2014 Anthocyanin stability of teak (*Tectona grandis*) leaf extract against pH and temperature treatments *J*. *Apl*. *Teknol*. *Pangan* **3** 2 60–63. [In Indonesian]
[12] Pujilestari T 2014 The effect extraction method and fixation of natural dyes to color fastness on cotton batik *Dinamika Kerajinan dan Batik*. **31** 1 31–40. [In Indonesian]
[13] Rahayuningsih T, Noerhartati E 2016 Extracting the source of basic colors as a natural dye of batik *Research Report* Universitas Wijaya Kusuma Surabaya Indonesia. [In Indonesian]
[14] Nilamsari Z, Giari N 2018 Trial of natural dyes mixed of secang fruit and mango leaves on prime cotton fabric *J*. *Seni Rupa* **6** 1 839–847. [In Indonesian]
[15] Gulrajani M L 2001 Present status of natural dyes *Indian J*. *Fibre Text*. *Res*. **26** 1–2 191–201.

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

ORIGINALITY REPORT

17%	16%	1%	0%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	iopscience.iop.org Internet Source	16%
2	M.H. Rodiah, S. Noor Hafizah, H. Noor Asiah, I. Nurhafizah, M.N. Norakma, I. Norazlina. "Extraction of natural dye from the mesocarp and exocarp of Cocos nucifera, textile dyeing, and colour fastness properties", Materials Today: Proceedings, 2021 Publication	<1%
3	"Handbook of Renewable Materials for Coloration and Finishing", Wiley, 2018 Publication	<1%

Exclude quotes	Off	Exclude matches	Off
Exclude bibliography	On		