Markisa fruit (*Passiflora edulis* var. *flavicarpa*) as a fixation material of natural colour of mangrove waste on batik

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Abstract. The process of natural colouring of batik using mangrove waste with the markisa fruit as a fixation material has been reported. In this experiment, the fixation material of markisa fruit has been compared with the commonly used fixation materials, such as CaCO$_3$, AlK(SO$_4$)$_2$, and FeSO$_4$ as material controls. Both grey scale and staining scale have been used as standard evaluations. Based on the Indonesian National Standard (SNI) it can be shown that batik with markisa fruit as a fixation material has a colour fastness value against average washing at good-excellent level (4-5) and colour fastness value to sunshine is moderate-excellent level (3-5). Thus, we conclude that Markisa fruit can be used as a fixation material in the colouring process of natural colour batik from mangrove waste.

1. Introduction

Nowadays the use of synthetics dyes in the batik making processes is still more popular than natural dyes because of the colour lasting, easy to get, and practical in use. The negative impact of the use of synthetics dyes could lead to environmental pollution and harmful to health. This is due to the presence of toxic substances contained in synthetic dyes. It gets serious attention from expert who develops natural dyes [1-3]. In the past, natural dyes were commonly used in the process of batik-making. On the one hand, natural dyes have advantages that are environmentally friendly [4]. On the other hand, natural colour substances have weaknesses, including lack of availability, soft in colours, low reproduction power and easy to fade [2]. To get a strong colour and fastness required the existence of a locking solution (fixation material) that can fix the colour. The commonly used fixation are lime (CaCO$_3$), Alum (AlK(SO$_4$)$_2$), and Lotus (FeSO$_4$) [5].

Fixation material that normally employed is chemical substances. It was needed a natural fixation materials., i.e., the Markisa fruit. The reason for the selection of Markisa fruit as an alternative fixation material is the presence of citric acid which can be used as metal ion binder. Markisa fruit also contains phenolic compounds [6,7]. It could be form hydrogen bonds with the carboxyl group of protein fibers. This is the first study is to test whether the Markisa fruit can be used as an alternative of natural fixation materials on the colouring process of batik from mangrove waste.

Pekalongan Municipality develops mangrove area. Leaves, fruits, and mangrove roots result in a lot
of mangrove waste every day. It has only been collected and burned. Waste management has not done well. Previous study revealed that mangrove waste could be utilized as a natural dye [2][5][8]. In the process of natural colouring batik, it is still using fixation materials from synthetic chemical substances such as lime, alum, and lotus. It is necessary to look for both the dyeing and the fixation process using natural materials.

This study aims to test the Markisa fruit (*Passiflora edulis* var. *flavicarpa*) as a fixation materials to the process of natural colouring of batik dyes from mangrove waste.

2. Methods

2.1 Problem definitions

The fixation materials that is normally employed are lime (CaCO$_3$), Alum (AlK(SO$_4$)$_2$), Lotus (FeSO$_4$). According to the background, the problem definitions in this study as follow: Is the markisa fruit be able to use as an alternative fixation materials on the process of natural colouring of batik by using natural dye from mangrove waste?

2.2 Experimentation

In this study, the dependent variable is colour fastness which is expressed by grey scale and staining scale as well. While the independent variable is markisa fruit as the fixation materials. As the control variable are the fixation materials that are normally employed, such as lime (CaCO$_3$), alum (AlK(SO$_4$)$_2$), and lotus (FeSO$_4$). The grey scale is tested against fastness of the 40°C wash and staining scale is stated by the colour fastness against daylight. Both grey scale and staining scale have been used as standard evaluations then comparing to the Indonesian National Standard (SNI).

The study was conducted in April – June 2017 at Pekalongan Batik Museum for the batik-making processes and Central Testing Laboratory of Batik and Craft (BBKB) Yogyakarta for the colour fastness testing.

The materials used in this study are: (1) mangrove waste extract came from root, leaf, and fruit, (2) Primissima cotton fabric, (3) fixation materials, those are lime (CaCO$_3$), alum (AlK(SO$_4$)$_2$), lotus (FeSO$_4$), and Markisa fruit (*Passiflora edulis* var. *flavicarpa*), (3) Turkey Red Oil (TRO), (4) soda ash (Na$_2$CO$_3$), and (5) batik waxes. While the tools used are large bucket, small bucket, pot, stove, wood stirrer, glove, blender, strainer, clamp, table batik tasting.

The study was conducted with the following steps:

2.2.1. Preparation. The mangrove waste was dried for 2 (two) weeks then extracted using water as a solvent with a ratio of 1:10. The cotton fabric soaked in TRO fluid for 2 (two) hour then washed with clean water and dried naturally (without sunlight) only just airy. After this, preparing the solution of lime, alum, and lotus respectively 50 grams per liter of concentration and concentration of markisa fruit was 20cc/ liter.

2.2.2 Batik-Making. Fabrics that have been washed out with TRO then given batik pattern by using waxes. Batik-making is intended to make batik patterns on the fabric. In this study, we conducted Batik-making by using stamp and hand-made batik pattern.

2.2.3 Colouring. The fabric that has been made batik pattern is coloured by immersion into mangrove waste extract for 7 (seven) times immersion. Each cotton fabric dyeing process is dried naturally (aerated).

2.2.4 Fixation. Batik that has been dipped into natural dyes from mangrove waste dipped into fixation solution, i.e. (lime, alum, lotus, and markisa fruit) then dried naturally (aerated) for 1 (one) night.

2.2.5 Pelorodan. This is meant to remove the waxes attached to batik. Pelorodan is done by dipping batik cloth into boiling water that has been given soda ash with a concentration of 50 grams/liter.

2.2.6 Testing. The resulting batik is tested against the fastness of the 40°C wash and the colour fastness against daylight. The results obtained are compared to the Indonesian National Standard. For testing of fastness against washing 40°C using SNI ISO 105-A 06: 2010, SNI ISO 105-A 02: 2010, SNI ISO 105-A 03: 2010 and SNI ISO 105-A 03: 2010 testing. The colour fastness test against day
light using the SNI ISO 105 - B01: 2010 and SNI ISO 105 - A02: 2010. The test was conducted at the Central Testing Laboratory of Batik Craft (BKKB) Yogyakarta.

3. Results and discussion
The results of natural colour batik from mangrove waste by using 4 (four) fixation materials are presented in the following table.

| Mangrove waste | Lime (1) | Alum (2) | Lotus (3) | Markisa (4) |
|----------------|----------|----------|-----------|-------------|
| Root (A)       | ![Image](image1.png) | ![Image](image2.png) | ![Image](image3.png) | ![Image](image4.png) |
| Leaf (B)       | ![Image](image5.png) | ![Image](image6.png) | ![Image](image7.png) | ![Image](image8.png) |
| Fruit (C)      | ![Image](image9.png) | ![Image](image10.png) | ![Image](image11.png) | ![Image](image12.png) |

Table 1 shows that the different fixation materials will produce different colours. This is in accordance with statement of Samanta & Konar that the difference in fixation will give different colour directions [9]. Lime produces brown colour; alum produces light brown colour, lotus produces brown colour black. The markisa fruit produces light brown as in the alum fixation. Previous research findings revealed that mangrove bark is rich in tannin compounds and can produce a reddish-brown colour [10]. Cotton fabrics dyed into natural dyes from mangrove waste will form hydrogen bonds between phenol hydroxy groups of tannin compounds in mangrove wastes with hydroxyl groups of cellulose fibers [5]. Fixation uses a material containing a metal complex due to its characteristic having the ability to form a coordination complex with a dye molecule [2]. Lotus has ability to form coordination complexes and to chelate with the dye molecule readily. While alum tends to form quite strong bonds with the dyes but not with the fiber [11].

3.1 Colour fastness testing against 40 °C wash
The results of laboratory test of colour fastness to washing 40 °C gives staining scale value as in the following Table 2.
Table 2. Result of study

| No | Code | Colour Changes | Acetate | Cotton | Polyamide | Polyester | Acrylate | Wool |
|----|------|----------------|---------|--------|-----------|-----------|----------|------|
| 1  | A1   | 4-5            | 4-5     | 4-5    | 4-5       | 4-5       | 4-5      | 4-5  |
| 2  | A2   | 4-5            | 4-5     | 4-5    | 4-5       | 4-5       | 4-5      | 4-5  |
| 3  | A3   | 4              | 4-5     | 4-5    | 4-5       | 4-5       | 4-5      | 4-5  |
| 4  | A4   | 4-5            | 4-5     | 4-5    | 4-5       | 4-5       | 4-5      | 4-5  |
| 5  | B1   | 4-5            | 4-5     | 4-5    | 4-5       | 4-5       | 4-5      | 4-5  |
| 6  | B2   | 4-5            | 4-5     | 4-5    | 4-5       | 4-5       | 4-5      | 4-5  |
| 7  | B3   | 4              | 4-5     | 4-5    | 4-5       | 4-5       | 4-5      | 4-5  |
| 8  | B4   | 4-5            | 4-5     | 4-5    | 4-5       | 4-5       | 4-5      | 4-5  |
| 9  | C1   | 4              | 4-5     | 4-5    | 4-5       | 4-5       | 4-5      | 4-5  |
| 10 | C2   | 4-5            | 4-5     | 4-5    | 4-5       | 4-5       | 4-5      | 4-5  |
| 11 | C3   | 4              | 4-5     | 4-5    | 4-5       | 4-5       | 4-5      | 4-5  |
| 12 | C4   | 4-5            | 4-5     | 4-5    | 4-5       | 4-5       | 4-5      | 4-5  |

Note:
Test Method:
SNI ISO 105-C06:2010
SNI ISO 105-A02:2010
SNI ISO 105-A03:2010
A = Root, B = leaf, C = Fruit
1 = lime, 2 = alum, 3 = lotus, 4 = Markisa

Table 2 shows the colour staining scale of batik against 40°C washing with the four different fixation materials. Both lime and alum fixation materials, the colour changes had a staining scale value of good to excellent (4-5), while lotus had staining scale value of good level (4). The markisa fruit fixation material also had staining scale value of good to excellent (4-5). As compared with the commonly used fixation materials such as lime, alum, and lotus. It has no different tests result. The overall colour fastness of batik was good to excellent. This is possible because the dye molecule is still bonded inside the fabric fibers. The metal ions form a coordination bond with the dye molecule so that it does not dissolve in water [5]. The use of fixation materials could enhances the fixation of natural colourant on the fibre by the formation of the complex with the dyes [12].

Meanwhile, the content of citric acid in markisa fruit is quite high, that is 2.4 – 4.8%. The chemical properties of citric acid are capable of binding metal ions to be used as preservatives [13].

According to Indonesian National Standard (SNI) the result of fixation (colour locking) for staining scale at least 3 (moderate). Thus it can be argued that markisa fruit can be used as a fixation material in the process of batik making natural colour from mangrove waste.

3.2 Colour fastness testing against day light
Table 3 shows the result of the grey scale value on the colour fastness against day light with the four different fixation materials. Both lime and lotus fixation materials, the colour changes had a grey scale value of moderate to good level (3-4), while alum had the grey scale value of good level (3). The markisa fruit had a grey scale value of moderate to excellent (3-5). According to Indonesian National Standard (SNI), the quality of batik primissima cotton fabrics should meet good level (4). Thus, the grey scale value that meets the standard quality of primissima cotton fabrics is batik with the alum and markisa fixation materials. Cotton fabrics with natural dye extracts from mangrove wastes accompanied by metal complex fixation generally can improve the properties of ultraviolet (UV) protection to good and very good levels [5].
Table 3. Colour fastness result

| No | Code | Colour fastness against day light Grey Scale | Test Method |
|----|------|---------------------------------------------|-------------|
| 1  | A1   | 3-4                                         | SNI ISO 105 – B01 : 2010 |
| 2  | A2   | 4                                           | SNI ISO 105 – A02 : 2010 |
| 3  | A3   | 4                                           |             |
| 4  | A4   | 4                                           |             |
| 5  | B1   | 3-4                                         |             |
| 6  | B2   | 4                                           |             |
| 7  | B3   | 3-4                                         |             |
| 8  | B4   | 4-5                                         |             |
| 9  | C1   | 3-4                                         |             |
| 10 | C2   | 4                                           |             |
| 11 | C3   | 3-4                                         |             |
| 12 | C4   | 3-4                                         |             |

Note:
A = Root, B = leaf, C = Fruit
1 = Lime, 2 = Alum, 3 = Lotus, 4 = Markisa

4. Conclusion
The process of natural colouring of batik using mangrove waste with the markisa fruit as a fixation material has been successfully conducted. Based on the Indonesian National Standard (SNI) it can be shown that batik with markisa fruit as a fixation material has a colour fastness value against average washing at good-excellent level (4-5) and colour fastness value to sunshine is moderate-excellent level (3-5). Thus, we conclude that Markisa fruit can be used as a fixation material in the colouring process of natural colour batik from mangrove waste.

It is recommended for further research on colour fastness to rubbing and sweat to cotton fabrics result of colouring to use dye extract of mangrove waste and markisa as fixation.

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