



## Utilization Of Rhizophora Stylosa Bark For Natural Dyeing On Cotton Batik Fabric



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### ABSTRACT

*The Rhizophora stylosa mangrove or commonly known as Red Mangrove grows in coastal areas with a saltwater and muddy environment. Natural dyes are extracted from such plant parts as roots, leaves, flowers, stems, and fruits. Natural dyes have distinctive colors and are environmentally friendly compared to synthetic dyes. The use of such natural dyes as mangroves can contribute to the green movement by minimizing the number of pollutants. The objective of this study was to analyze the result of Rhizophora stylosa mangrove stem bark color and its quality in cotton batik fabric. The mangrove stem bark is applied as the raw material for natural dyes. The bark is extracted by boiling it to obtain a natural dye solvent. The dye is tested on cotton-based fabrics by mordanting or fixation using alum (KAl(SO4)2·12H2O), calcium oxide (Ca(OH)2), and ferrous sulfate (FeSO4). Red mangrove bark (Rhizophora stylosa) can produce natural colors of grey, brown, and peach on fabrics made of natural fibers (cotton fabrics) in batik. The hue and color depend on the type of the applied fixative material and the temperature in the process of boiling the fabric to release the wax on the batik (lorod). This research highlight that the red mangrove (Rhizophora stylosa) can be used as a dye in batik-making.*

**Kata Kunci:**  
Rhizopora stylosa, Zat  
Pewarna Alami, Tekstil,  
Batik.

### ABSTRAK

Jenis mangrove Rhizophora stylosa atau biasa dikenal dengan Mangrove Merah tumbuh di daerah pesisir dengan lingkungan air asin dan berlumpur. Pewarna alami merupakan larutan pewarna yang diekstrak dari bagian tanaman seperti akar, daun, bunga, batang dan buah. Pewarna alam memiliki warna yang khas dan lebih ramah lingkungan dibandingkan dengan pewarna sintesis. Penggunaan pewarna alami, termasuk mangrove dapat berkontribusi pada gerakan penghijauan dalam meminimalkan jumlah limbah yang tercemar. Tujuan penelitian ini adalah untuk

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menganalisis hasil warna kulit batang pohon mangrove *Rhizophora stylosa* dan kualitasnya pada kain batik berbahan katun. Bagian tumbuhan bakau yang digunakan sebagai bahan baku pewarna alami adalah kulit batangnya. Ini diekstraksi dengan merebus kulit kayu dengan air untuk mendapatkan pelarut pewarna alami. Pewarna diuji terhadap kain berbahan dasar kapas dengan mordant atau fiksasi menggunakan tawas ( $KAl(SO_4)_2 \cdot 2H_2O$ ), kapur ( $Ca(OH)_2$ ) dan tunjung ( $FeSO_4$ ). Kulit batang bakau merah (*Rhizophora stylosa*) dapat menghasilkan warna pada kain dari serat alam (kain katun) sebagai pewarna alami pada batik dengan warna abu-abu, coklat, dan jingga dengan tunjung fixation menghasilkan kualitas warna yang lebih baik dibandingkan dengan menggunakan tawas dan kapur. Corak dan warna tergantung pada jenis bahan fiksatif yang digunakan dan suhu dalam proses perebusan kain untuk melepaskan lilin pada batik (lorod). Penelitian ini menyimpulkan bahwa mangrove merah (*Rhizophora stylosa*) dapat digunakan sebagai pewarna pada pembuatan batik.



## INTRODUCTION

For centuries, our ancestors have applied natural colors for textile dyes. Since ancient times, in Indonesia, natural dyes from nearby plants have been used to dye batik fabrics. However, since 1960 their use has been replaced by synthetic dyes. Recently, natural dyes have been utilized to be applied in the batik textile industry (Suheryanto, 2017: ii). Batik craftsmen are familiar with the plants traditionally used as the natural dyes since ancient times and most of the batik textile colors can be obtained from plants (Wulandari, 2011: 79). The common concern on the environmental conservation through the reduction of the use of synthetic chemicals has emphasized the need to explore new and sustainable sources of environmentally friendly dyes for the textile sector (Fatimah et al, 2019; 3081). The use of natural dyes has regained its popularity and accordingly the demand for such natural dyes is likely to increase (Hüseyin and Ibrahim, 2018:44). Overall, natural dyes are environmentally friendly, non-polluting, healthy, and an alternative dye for cotton fabrics (Shudir et al, 2019: 1161). Natural dyes applied to cotton fibers require a mordanting process as a resistant and everlasting color enhancer (Cristina, 2018: 21). Natural dyes are produced by boiling such natural ingredients (extraction) like leaves, wood, flowers, and other organic materials to result in natural dyes (Mayliana, 2016:10). Besides that, natural dyes are non-toxic, non-polluting, harmless to health, and contain antioxidants and antimicrobials. The main idea of using natural dyes is to avoid environmental pollution and avoid toxic and allergic reactions associated with the use of synthetic dyes (Aishwarya and Anchana, 2014:01). Besides their ecological functions, mangrove ecosystems have such various extraordinary economic benefits as a natural dye for batik (Idris et al, 2017: 14). The skill of batik art is traditionally inherited across Indonesian generations and has become one of the sources of people's livelihoods (Benito in Susant, 1980:01). Sustainability of mangrove forests for agriculture, aquaculture, or other interests has to be based on such rational use of mangrove ecosystems as 1) Selective development of commodities to achieve the expected agricultural development goals; 2) Preservation against the clearing of mangrove land to avoid the loss of its physical function; 3) Conservation through replanting and setting aside some parts of lands after the clearing of mangrove land as a green line; 4) Efficient use of mangrove land by considering the trade-off of economic and ecological functions (Gayo et al, 2009:16-20).

The use of natural textile dyes is increasingly very important when people have a higher environmental awareness to reduce or avoid the use of harmful synthetic dyes. However, the use of natural dyes throughout the world is still limited to craftsmen or artists and small/home-scale industries which result in environmentally friendly textile productions of high value (Alemayehu and Teklemariam, 2014:61). Some textile industries have polluted the environment a lot due to the excessive use of synthetic dyes from petroleum sources which endanger human health and aquatic biodiversity. Therefore, natural dyes can solve this problem (Kanti, 2019:40).

### Mangrove *Rhizophora stylosa*

The word mangrove derives from the ancient word of Malay language *mangi-mangi* which refers to the *Avicennia* clan and is still used today in Eastern Indonesia (Rusila Noor, et al 1991: in Idris, 2017: 02).

The salt-tolerant ecosystem plant of *Rhizophora stylosa* grows in such tidal areas as coastal areas and river mouths flooded at high tide and free from inundation at low tide. According to Idris

et al (2017: 3). In general, the *Rhizophora stylose* has similar characteristics as other types of mangroves. However in particular, some differences can be observed. First, it has a slightly softer stem and supporting roots than other types. They are rather small and reddish, which functions to support the stem to remain upright against the waves. Second, it has cylindrical, green to brown, and speckled fruits. Third, it has wide elliptical sharp-edged, large, and thick leaves to store water. Fourth, it has fork-shaped flowers with a white crown. Mangroves have a complicated growth by adjusting to their habitat. Mangroves grow through elongated and pointed cylindrical fruit (propagules). When they fall to the ground, they will stick to the muddy ground or sand on a beach flooded with seawater. However, if the mangrove grows deep in the shore, it will take a long time for the propagules to stick and grow. According to Kusmana et al. (2003), ripe mangrove fruit or propagules are characterized by the release of the hypocotyl from the fruit chip, and the released fruit will be carried away by rivers and waves (in Rusdiana et al., 2016: 68).

### Natural Dyes

Natural dyes are obtained from both animals (lac dyes) and plants, which can be derived from roots, stems, leaves, fruit, bark, and flowers. The resulting color tends to be paler and has distinctive characteristics. Wulandari, 2011: 79). Natural dyes are extracted from various parts of plants using water as a solvent at high or low temperatures. The substances taken vary depending on the source and the group it contains (Purnomo in Lestari, 2015: 5). The appearance of the color produced by natural dyes is influenced by the binder used (Prima and Ivon, 2013: 06). Many kinds of research on the production of natural textile dyes both from plants and biotechnological processes have been carried out. One way to find out if a plant has a color to dye textiles is by pounding the part of the plant with our finger. The color will be formed. If the color is persistent, then the plant has the potential natural dye (Elsahida., et al, 2019:02). The use of natural dyes in the process requires an element called mordant to form a bond between the fabric and the particles of the natural dye. Mordant provides a chemical reaction to ensure the absorption of the dye into the textile material and improve the color of the fabric by increasing the color resistance (Singh and Srivastava, 2015:06). In Indonesia, the fixation or mordanting process usually uses metal mordants such as alum ( $KAl(SO_4)_2 \cdot 12H_2O$ ), lime ( $Ca(OH)_2$ ), and Tunjung ( $FeSO_4$ ) (Darsih., et al, 2019:106).

### About Batik

Batik is a cloth decorated with motifs made with wax which prevents the motifs from staining during the dyeing process. It prevents color from entering the covered parts of the fabric. The melted wax is applied to the fabric using a small spray applicator called a canting, which is made of copper attached to the end of a light four-inch wooden or bamboo handle (Ishwara et al, 2012: 23). It can be said that batik making is a recalibrated textile technique using a resist (Wardhani and Pangabea. 2003: 20). Batik cloth is a pictured cloth decorated with a special manufacturing process using wax (Setiawati, 2004: 9) On October 2, 2009, batik was inaugurated by the United Nations Educational, Scientific and Cultural Organization (UNESCO) as an original world cultural heritage of Indonesia. Since then, October 2 has been commemorated as "Batik Day" in Indonesia (Wulandari, 2011: 7). Batik art is believed to have existed since the days of the Majapahit kingdom as evidenced by the discovery of a statue in the Ngrimbi temple depicting the figure of Raden Wijaya, the first king of Majapahit (reigned from 1294 to 1303) wearing a kawung-patterned batik cloth. With its



large area, Majapahit Kingdom contributed much to the widespread recognition of batik in the archipelago (Wulandari, 2011:12) in the Ngrimbi



Figure 1. *Rhizophora Stylosa*  
(Source: Personal Document, 2019)

## METHOD

This study aims to identify an appropriate formula for natural dyes produced from the waste bark of red mangrove trees (*Rhizophora stylose*) for cotton batik cloth. It is extracted at a temperature of 70°C for 3 hours, followed by a mordanting process using such types of dyes mordanting solution as alum ( $KAl(SO_4)_2 \cdot 2H_2O$ ), lime ( $Ca(OH)_2$ ), and Tunjung ( $FeSO_4$ ). Mangrove bark was taken from the Pari Island and Sebira Island in the Pulau Seribu of DKI Jakarta. The dyes were then applied to a cotton batik cloth and were analyzed using a qualitative descriptive method by looking at the quality of the natural dyes produced by the waste of mangrove bark on batik cloth.

### 1. Process of Making Mangrove Bark Waste Dye

To produce natural dyes, naturally rotten, broken, or damaged *Rhizophora stylose* bark is needed. The followings are the steps for making a solution of mangrove bark dye. First, rotten or broken mangrove bark is collected from the hard stems, instead of the roots. Second, once collected, the mangrove bark is dried in the sun for 3 days until it is completely dry. Third, 1 kilogram of dried mangrove bark was extracted with 10 liters of water. Fourth, the mangrove bark is boiled and extracted until approximately 4 or 5 liters of water to result in a reddish tannin substance. Fifth, after the boiling process is complete, allow the solution to drain and it can be used to dye the fabric.

## 2. Testing the Effect of Number of Dyeing on Color Quality

Colored fabrics are assessed by colorimetric specification using grayscale to measure color change. In this test, it can be observed the influence of dyeing on the quality of the resulted color change. The effect of the number of dyeing was tested by comparing several samples dipped in a dye solution of mangrove bark waste. In each mordant solution, 4 samples were tested with dyeing once, 5 times, 10 times, and 20 times respectively. The mixture of fixation types was also tested with different mordant metals to determine the resulted color of the fabric caused by the mixing reaction.

## 3. The Process of Using Mangrove Bark Waste Dye Solution As Textile Dye

After collecting the natural dye of mangrove bark, 20 sheets of mordanted primissima cotton cloth of 13 cm x14 were prepared. The cloth was dipped in 440 ml of the solution of mangrove bark dye. The dyeing process was repeated at 10-minute intervals, and after that, the cloth was left for one night to maximize the color absorption on the fabric. The colored cloth that had been left overnight then underwent a fixation process by dipping the cloth into the fixation solution (mordanting). Different types of mordanting are applied on the fabric. The mordant metals of alum ( $KAl(SO_4)_2 \cdot 12H_2O$ ), lime ( $Ca(OH)_2$ ), or tunjung ( $FeSO_4$ ) are used individually or applied in combination. Each mordanting solution is adjusted according to the following respective doses:

- a. Alum solution: 70 grams of alum mixed with 1 liter of water.
- b. Lime solution: 30 grams of lime mixed with 1 liter of water.
- c. Tunjung solution: 50 grams of Tunjung mixed with 1 liter of water.



Figure 2. *Rhizophora Stylosa* Bark i(Source: Personal Document, 2019)



| <i>Color Quality Score</i> | <i>Color Change</i> | <i>Value</i> |
|----------------------------|---------------------|--------------|
| 5                          | 0                   | Very good    |
| 4-5                        | 0.8                 | Good         |
| 4                          | 1.5                 | Good         |
| 3-4                        | 2.1                 | Fairly Good  |
| 3                          | 3.0                 | Fair         |
| 2-3                        | 4.2                 | Bad          |
| 2                          | 6.0                 | Bad          |
| 1-2                        | 8.5                 | Poor         |
| 1                          | 12.0                | Poor         |

Table 1. Color Quality Scores in *Grey-scale*

## RESULT AND DISCUSSION

### 1. Color Result Analysis

The exploration of the dye solution with different fixation solutions resulted in different colors due to the different reactions of the fixation solution. The tests using the grayscale found an effect of the number of dyeing on the quality of the resulting colors. It was found that fixation using alum ( $KAl(SO_4)_2 \cdot 12H_2O$ ) produces an orange to brown color, while the fixation using lime ( $Ca(OH)_2$ ) produces an orange to reddish-brown color and fixation using a tunjung ( $FeSO_4$ ) produces a gray to black color. The first row of the fixation table that describes the types of alum, lime, and tunjung shows that the dyeing process carried out once has resulted in a slightly pale or low color. The color change on alum fixation showed a score of 0.8 (good), while on lime fixation it was 0.7 (good), and on tunjung fixation, it was 0.5 (good). The second column and row show slightly, but not significantly darker and denser colors. This was evidenced by the increasing scores of color changes. They are 0.7 (good) for alum fixation, 0.6 (good) for lime fixation, and 0.4 (nearly very good) for tunjung fixation, respectively. In the third row and column, the color intensity increased with color change scores of 0.6 (good) for alum fixation, 0.5 (good) for lime fixation, and 0.3 (close to very good) for tunjung fixation. In the fourth column, the dyeing process was carried out twenty times, resulting in a very thick color with a score of 0.5 (good) for alum fixation, 0.4 (nearly very good) for lime fixation, and 0.0 (very good) for tunjung fixation. Mixed fixation is explored by combining some fixation solutions, resulting in a different color from the unmixed fixation. In the first column, the fixation used a mixture of alum and lime, resulting in a yellowish-brown color with a color change score of 0.5 (good). In the second column, the fixation used tunjung and lime, resulting in dark brown and reddish colors with a color change score of 0.1 (very good). The third column, using tunjung and alum fixation, produces a dark brown color with a color change rate of 0.1 (very good). The fourth column, using alum and tunjung fixation, produces a gray color with a slightly purplish color with a color change score of 0.3 (nearly very good). The color resulting from the fixation mixture was also influenced by the number of dyeing of the mangrove skin waste color solution and the fixation solution used first. The dyeing test and fixation process showed that fixation using



tunjung solution ( $\text{FeSO}_4$ ) has a better color quality than alum solution ( $\text{KAl}(\text{SO}_4)_2 \cdot 2\text{H}_2\text{O}$ ) and lime ( $\text{Ca}(\text{OH})_2$ ). Meanwhile, the lime solution has a better color quality than alum. The results of the fixation solution mixing test show that the color quality will be better if the first fixation uses tunjung solution and is repeated with such other fixation solutions as alum and lime.

## 2. Application on Batik

When the mangrove bark waste dye has been explored, the next research stage is applying the resulted color to a batik cloth. This application test was conducted to ensure the stability of the color produced and influenced by the batik process. The process of batik making has several main stages, the first of which is to attach or inscribe wax on the fabric as a color barrier. The process aims to produce a variety of motifs and coloring. The second process is coloring the fabric using a natural color solution from mangrove bark waste. The third process or the final stage is releasing the wax by boiling it in boiling water. The wax in batik will melt in hot temperatures. The wax released from the fabric will result in a motif. When the wax was boiled at the temperature of  $80^\circ\text{C}$  -  $100^\circ\text{C}$ , 200 grams of soda ash ( $\text{Na}_2\text{CO}_3$ ) is added to the boiling water to facilitate the wax release process. The mixing process and temperature change the color of the mangrove bark as can be observed from the results of its application to the batik.

### Analysis of Color on Batik Fabric


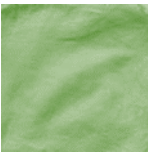


When applying the natural dye of *Rhizophora stylose* bark, the researchers made three applications with different processing techniques and the number of dyeings. This process resulted in a relatively persistent or unchanging color. The three results show how the batik process affects the color quality. In the first application, the reddish color on the basic background resulted from the fixation of alum ( $\text{KAl}(\text{SO}_4)_2 \cdot 2\text{H}_2\text{O}$ ) by immersing it 10 times. However, this result was different from the findings in the natural dye exploration process, where in color exploration with 10 dippings, the resulting wax tends to be lighter brown due to the effect of the wax block process that covers it. Consequently, the color is darker when the wax is removed. The fish motifs and patterns on the background produce a very dark blackish brown color due to the 20-time dyeing process with tunjung fixation ( $\text{FeSO}_4$ ). The brown color is also affected by the application of alum ( $\text{KAl}(\text{SO}_4)_2 \cdot 2\text{H}_2\text{O}$ ) in the first fixation. The mixture was fixed, and the resulted color is in line with the color exploration in the mixed fixation table, where the mixture of the fixation of alum and tunjung produces a blackish-brown color. The second application with lime ( $\text{Ca}(\text{OH})_2$ ) fixation on the orange motifs, resulted in a stable color according to the color produced in the exploration process for natural dyes with a lime fixation table with 10 dippings. In the second process, 5 times re-dyeing was carried out with tunjung fixation ( $\text{FeSO}_4$ ), resulting in mixed fixation and producing a slightly purplish gray color. However, in this batik, the gray color tends to be darker. The third application, which has a different process from the previous one, covers the entire unwaxed background and colors the motif with alum fixation ( $\text{KAl}(\text{SO}_4)_2 \cdot 2\text{H}_2\text{O}$ ) resulting in orange color. The orange color is covered with wax and fixed with tunjung ( $\text{FeSO}_4$ ) which produces a gray color. After the wax was removed the previously white background turned into a yellowish-white color. This can also be affected during the boiling process to release the wax. The remaining decomposed dye through



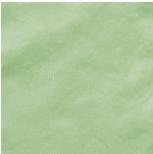





boiling absorbs into the fabric fibers which changed the previously white to yellowish. Therefore, before boiling, we need to wash the cloth thoroughly to clean up any residual dye.


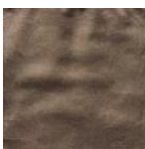
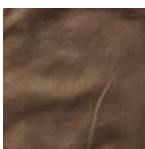
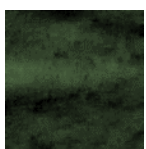
**Alum fixation ( $KAl(SO_4)_2 \cdot 2H_2O$ )**

|   |   |  |   |
|---|---|--|---|
|  |  |  |  |
| 1 time of dye dipping.<br>1 time of alum fixation.<br>(0,8)                       | 5 times of dye dipping.<br>1 time of alum fixation.<br>(0,7)                      | 10 times of dye dipping.<br>1 time of alum fixation.<br>(0,6)                      | 20 times of dye dipping.<br>2 times of alum fixation.<br>(0,5)                      |


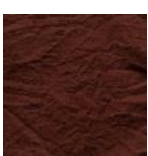
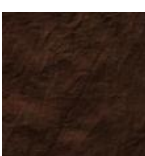
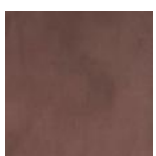
**Lime fixation ( $Ca(OH)_2$ )**

|  |  |   |  |
|--|--|---|--|
|  |  |  |  |
| 1 time of dye dipping.<br>1 time of lime fixation.<br>(0,7)                        | 5 times of dye dipping. 1 time of lime fixation.<br>(0,6)                          | 10 times of dye dipping. 1 time of lime fixation.<br>(0,5)                          | 20 times of dye dipping. 2 times of lime fixation.<br>(0,4)                          |

**Tunjung fixation ( $FeSO_4$ )**

|   |   |  |   |
|---|---|--|---|
|  |  |  |  |
| 1 time of dye dipping.<br>1 time of tunjung fixation.<br>(0,5)                      | 5 times of dye dipping.<br>1 time of tunjung fixation.<br>(0,4)                     | 10 times of dye dipping.<br>1 time of tunjung fixation.<br>(0,3)                     | 20 times of dye dipping.<br>2 times of tunjung fixation.<br>(0,0)                     |

**Mixed Fixation**

|   |   |  |   |
|---|---|--|---|
|  |  |  |  |
| 5 times of dye dipping. 1 time of alum fixation.                                    | 1 time of dye dipping. 1 time of tunjung fixation. Dip                              | 5 times of dye dipping. 1 time of  | 5 times of dye dipping. 1 time of   |

|   |  |   |   |
|---|--|---|---|
| Another 5 times of dye dipping and 1 time of lime fixation.<br>( 0,5) | again 10 times with dye and 1 time of lime fixation.<br>( 0,1) | tunjung fixation. Another 5 times of dye dipping and 1 time of alum fixation.<br>( 0,1) | lime fixation. Another 5 times of dye dipping and 1 time of tunjung fixation.<br>( 0,3) |
|---|--|---|---|

Table 2. Natural Dye Exploration Result



Figure 3. Canting Use Process  
(Source: Personal Document, 2019)

| Implementation 1 | Description   |
|------------------|---|
|                  | <p>Using a written batik technique with the first dyeing process ten times with alum fixation, then the process of closing the outside of the motif using wax. The second dyeing process is twenty times with tunjung fixation which produces a blackish-brown color.</p> |
| Implementation 2 | Description:  |





Using the technique of written batik. The first dyeing process was carried out by dyeing ten times using lime which produced a reddish-brown color, then the color was covered with wax, and the second dyeing was carried out five times with tunjung fixation which produced a gray-black color.

**Implementation 3**

**Description**



The technique of written batik is employed. The first process is closing using wax to produce a white color on the background of the batik cloth. Then, the dyeing process is carried out 5 times with alum fixation and then closed again using wax. In the next process, dipped back into the color solution 5 times with tunjung fixation, resulting in gray color.

Table 3. Implementation on Batik Cloth

**CONCLUSION**

The bark waste of Rhizophora stylose is a natural dye for textiles, especially batik cloth. The study finds that the color produced by the waste of mangrove bark extracted through the boiling process produces a variety of different colors depending on the number of dyeing and the type of fixation method. The more the dyeing process, the more concentrated the color will be. In the fixation process to produce several colors, alum fixation ( $KAl(SO_4)_2 \cdot 2H_2O$ ) will produce a brownish-orange color, and lime fixation ( $Ca(OH)_2$ ) will produce a reddish-orange color, while tunjung fixation ( $FeSO_4$ ) will produce such dark colors as blackish gray. Besides that, fixation mixing will also affect the resulting color. The application of natural colorant from mangrove bark waste into a batik cloth produces a stable color and is resistant to boiling during the wax release process. Therefore, natural colorant from mangrove bark waste can be used as batik colorant.

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