

The Application of Mahogany Bark (*Swietenia Mahagony L.*) for Natural Dyeing

Immas Lutfi Alfiyanti, Rois Fatoni, and Siti Fatimah

Faculty of Chemical Engineering, University Muhammadiyah Surakarta – Surakarta City, Ahmad Yani Street, Pabelan, Kartasura, Central Java, Indonesia, 57162

immaslutfi38@gmail.com

Abstract. Recently many batik industries owner have switched to using natural dyes because synthetic dyes in the long time have a negative impact on the environment. Natural dyes that are widely used are mahogany (*Swietenia Mahagony L.*) bark dyes. In the process of coloring batik fabric, there is stage of fixation. Fixation is the stage of binding the color with the fixator. There are three types of fixators used, namely alum ($\text{Al}_2(\text{SO}_4)_3 \cdot 12\text{H}_2\text{O}$), calcium oxide (CaO) and ferrous sulphate (FeSO_4) with certain concentrations. The owner of batik industries don't know yet the concentration of a strong and optimal fixator for binding natural dyes in batik fabric. The purpose of this study is to determine the type of strong fixator and optimal concentration of fixator for binding natural mahogany dyes on batik fabric. The owner of batik industries usually use an estimated concentration of 30 g / L to 100 g / L. In this study, the variables are 30 g / L, 60 g / L and 90 g / L in each type of fixator to test the color aging value. and color fastness to rub wet and dry. Judging from the value of R% (color aging) and color fastness test against wet and dry rubbing, it can be concluded that alum and calcium oxide are strong fixators that used with mahogany dyes and the most optimal concentration of alum and calcium oxide is 60 g / L.

Keywords: natural dye; mahogany bark; fixator; batik fabric

1. Introduction

According to Shawabkeh RA, & Tutunji MF, 2003 [1] the use of synthetic dyes can cause environmental pollution and is a hazardous material, because some dyes can be degraded into carcinogenic and toxic compounds. Full-color textile industry waste and organic chemicals from synthetic dyes. According to Kant.R, 2012 [2] mixing colloidal material with dye waste, can increase turbidity and make water look bad, smell, prevent sunlight penetration. The impact is the depletion of dissolved oxygen, decreased water quality and the death of living things that live in it due to lack of oxygen or contaminated with toxic compounds. Besides that when the waste is allowed to flow it will clog the pores of the soil resulting in loss of soil productivity, soil texture harden and prevent penetration of plant roots.

In this study mahogany bark was used. Mahogany bark is not only used by batik artisans in the Boyolali area. According to Indrianingsih, A.W., et al, 2013 [3] The batik industries owner in the city of Probolinggo also use mahogany bark as their batik coloring. The extraction of mahogany bark produce brownish red-brown color. The extract of Mahogany tree bark can be used to color the wood, Boo E, 1990 [4]. The extract is also used as a dye in the leather tanning process.

The uses of mahogany as natural dye were common among society in developing countries. Bangladeshi society accustomed to using the extraction of mahogany tree bark as a natural dye for

textiles, Lascurian C, 1996 [5]. The disadvantage of natural dyes is lower fade resistance than synthetic dyes. To obtain high fastness is needed a process of fixation (color generation) which aims to sharpen the color and so it does not fade easily. So far, the batik industries owner who use natural dyes still do not know the exact size of the fixator and the best type of fixator to generate the color of the natural dye.

Based on the description, the research was carried out in the form of a dye binding business using fixation materials such as alum, calcium oxide, and ferrous sulphate with concentrations of 30 g / L, 60 g / L and 90 g / L. The selection of fixation materials is based on the nature of substances that are relatively harmless to the environment. As a natural coloring agent, mahogany bark is extracted for 1 hour using a water solvent. In this research, the quality of natural dyes produced was tested for quality, namely the value of color fastness to rubbing wet and dry fabric and color aging test.

2. Methods

2.1. Materials

In this study using various materials. The most important ingredients are mori premisima fabric and natural mahogany bark extract which has been extracted. The next material is fixator consisting of alum ($\text{Al}_2(\text{SO}_4)_3 \cdot 12\text{H}_2\text{O}$), calcium oxide (CaO) and ferrous sulphate (FeSO_4). Furthermore, the material used in the *mordanting* process is the detergent brand Attack Jaz1 and soda ash (Na_2CO_3).

2.2. Method

2.2.1. Extraction of mahogany bark

Preparing extractor-evaporator tanks, stoves and raw materials to make the extract of mahogany bark. Put 1 kilogram of material into the evaporator-extractor tank then put water into the extractor-evaporator tank of 10 liters or up to the marking mark on the estimating tank. Close the extractor-evaporator tank with the tank cap. Turn on the stirring motor and stove at the bottom of the extractor-evaporator tank. Heats until the temperature reaches 100 °C. Maintain a temperature of 100 °C for 1 hour for the extraction process. Extracting and evaporating the water contained in the extract to obtain concentrated extract. After the process is complete, turn off the stove and the stirring motor. Open the extractor cover and cooled down for 30 minutes. Extracting the extract through the tap at the bottom of the extractor, then storing the extract in a bucket and inserting it into the jerry can. Take the residue in the form of the remaining mahogany bark which is accommodated in the filter tank in the extractor set tools.

2.2.2. Mordanting

Dissolving the detergent as much as 3 grams in 3 liters of water then soak the fabric into the detergent solution overnight. Then wash the fabric and squeeze the fabric. Preparing a *mordanting* solution by preparing 10 liters of water, 100 grams of alum and 30 grams of soda ash and the solution is boiled. After the water was boiled, the fabric that has been soaked overnight is boiled in a *mordanting* solution for ± 15 minutes. The *mordanting* solution and the fabric were left on overnight, then the fabric was dried

2.2.3. Application of Natural Dyes on Fabric

Cutting the fabric to be given a mahogany bark dye. Dip a fabric into the dye solution and soak it for 5 minutes with 5 dips.



Figure 1. Coloring of premise fabric in mahogany dyes 5 times of dyeing

2.2.4. Fixation

Making a fixator from alum, calcium oxide, and ferrous sulphate by dissolving 30 grams of alum / calcium oxide/ ferrous sulphate in 1 L of water, soaking fabric for 10 minutes to a concentration of 30 g / L. Dissolving 60 grams of alum / calcium oxide / ferrous sulphate in 1 L of water, soak a fabric for 10 minutes for a concentration of 60 g / L. Dissolving 90 grams of alum / calcium oxide / ferrous sulphate in 1 L of water, soak a fabric for 10 minutes for a concentration of 90 g / L.



Figure 2. Fixation results with various types and concentrations

2.2.5. Color Fading Resistance to Rubbing

First connecting the Crockmeter Plug to an electric current source. Test sample the dyed fabric is cut according to the provisions of the size 7.5 x 25 cm and 5 x 5 cm for the white fabric for the colored fabric scrub. Then the fabric is stretched and the edges are fastened to the tool. Attach a white fabric measuring 5x5 cm in the existing envelope in the rubbing section. Dry Rub test 5x5 cm white fabric pairs on the existing sheath on the rubbing section without being wet while the Wet Rub Test, 5x5 cm white fabric moistened with water and then dry with a tissue so that the condition is still moist and installed in the rubbed envelope. bring up zero on the counter and place the scorer on the material you want to test. Turn on the tool by pressing the ON button (Green color). If the number of rubbing is in accordance with the plan which is 10 times rubbing, stop the tool by pressing the OFF button. (Red). Color fastness testing can be rubbed with a dry system and wet rubbing. That is soaked in a white fabric with a size of 5x5 cm. After testing, the material that has been tested is then assessed for color staining that has stuck to the white fabric using a grey scale measuring instrument (Grey Scale) what is the value

of the staining? example value 3 (middle weak), Value 5 (very strong, means no fade / no stains). After completing the test, the crockmeter engine which has been connected to an electric current is to be removed from the socket.

2.2.6. Color Aging Test

First connecting the Computer Plug and Spectrophotometer to an electric current source. Turn on the computer that already has the UV-VIS PC program. Turn on the Spectrophotometer which is already connected to the computer. Then click 2x on the UV-VIS PC program image that is already on the monitor screen. Open the CONFIGURE menu, select PC CONFIGURE, exit the menu and fill in the printer type column that you want to use then click OK. Open the CONFIGURE Menu, select UTILITY, exit the UV-VIS PC menu, select ON (meaning: in the UV-VIS PC, the light should be on / all) then wait until the green mark on the monitor turns on for ± 10 minutes, then just click OK. Open the CONFIGURE Menu, select PARAMETER Exit the menu and fill in, for example select (R%) and then fill in the ring for the star column filled in 780nm and for the finish column filled in 380nm then in OK. Before testing to the fabric that has been colored, to put the chart / blank, the original ORIGINAL / STANDARD white fabric 5x5 cm is clamped to the ISR box inside the UP-PC then click BASELINE awaited until it shows the number 380nm. Beginning the test enter a sample fabric that has been varied or colored 5x5 cm in size is clamped on the ISR box on the UV-VIS PC then clicked STAR, wait until it is detected until the finish is 380nm, then the menu name file comes out, column 1 is named for the sample code and column 2 is given the name of the owner of the test sample. Then press OK. Then further testing with fabric samples that have varied and steps as in no.9 and so on. To find a graphic that is not yet visible on the monitor screen, open the PRESENTAGE menu, select RADAR, it will automatically display the graphic image that has been tested earlier. To find the file that has been tested open MANIPULE select PEAK PICK on the click and the image menu will appear then move up to the top so that the graphic image and the value of the test results are visible. To find the value one of the strongest R% numbers is taken, is the last order range between 1-5, the lowest, the smaller the R% value the fabric gets darker / darker. Conversely, if the value of R% is greater the color of the fabric becomes brighter or toward color to white. How to print, open OUTPUT in PEAK PICK, select the GRAPHIC PLOT menu, click directly out of the data and graphics.

3. Results and discussion

Color fastness is assessed by comparing the color changes that occur with color change standards issued by the International Standards Organization (ISO) and made by the Society of Dyers and Colorists (S.D.C) in the United Kingdom and the American Association of Textile Chemists and Colorists (AATCC) in the United States. The color change standard issued is the gray scale standard to assess the color change of the laundry and the staining scale to assess the color change due to staining on the white fabric. From the analysis results will be obtained figures that indicate the level of fastness.



Figure 3. Grey Scale

Table 1. Color Change Assessment on Gray Scale Standards

No	Color Fastness Value	Color Difference (CD)	Tolerance of Work Standards	Evaluate Color Fastness
1	5	0	0,0	Very Strong
2	4-5	0,8	± 0,2	Strong
3	4	1,5	± 0,2	Strong
4	3-4	2,1	± 0,2	Middle Strong
5	3	3,0	± 0,2	Middle Weak
6	2-3	4,2	± 0,3	Weak
7	2	6,0	± 0,5	Weak
8	1-2	8,5	± 0,7	Very Weak
9	1	12,0	± 1,0	Very Weak

The results of testing the dyes of mahogany bark on premise fabrics are done in two ways, namely testing the fabric of dry and wet rubbing with Grey Scale (GS / CD) and testing the fabric color aging. The process of testing for rubbing uses a tool called Crockmeter. Whereas the color aging test uses a UV-VIS PC Spectrophotometer. From the dyestuff testing process on the fabric that has been done, the dyestuff test results are obtained which can be seen in the table below.

Table 2. Test results for color fastness test against dry rubbing

Natural Dye	Concentration (g/L)	Fixator					
		(Al ₂ (SO ₄) ₃ .12H ₂ O)		CaO		FeSO ₄	
		GS	CD	GS	CD	GS	CD
Mahagony	30	4-5	2,0	4	4,0	4	4,0
	Value	Strong		Strong		Strong	
	60	4-5	2,0	4	4,0	4	4,0
	Value	Strong		Strong		Strong	
	90	4-5	2,0	4	4,0	4	4,0
	Value	Strong		Strong		Strong	

(CD = Color Difference)

The results of fabric color fastness testing against dry rubbing with Grey Scale, fabrics that have optimal color fastness on mahogany dyes are fabrics that are fixed using alum fixers with grades 4-5 (Strong) in various concentrations.

Table 3. Test results for color fastness test against wet rubbing

Natural Dye	Concentration (g/L)	Fixator					
		(Al ₂ (SO ₄) ₃ .12H ₂ O)		Cao		FeSO ₄	
		GS	CD	GS	CD	GS	CD
Mahogany	30	3-4	5,6	3	8,0	2-3	11,3
	Value	Middle Strong		Middle Weak		Weak	
	60	3-4	5,6	3-4	5,6	3	8,0
	Value	Middle Strong		Middle Strong		Middle Weak	
	90	3	8,0	3	8,0	3	8,0
	Value	Middle Weak		Middle Weak		Middle Weak	

*(CD = Color Difference)

The results of fabric color fastness testing against wet rubbing with Grey Scale, fabrics that have optimal color fastness on mahogany dyes are fabrics that are fixed using alum fixators at concentrations of 30 g / L and 60 g / L with grades 4-5 (Strong) and calcium oxide fixator at a concentration of 60 g / L. Fabrics with mahogany dyes fixed with tide fixators have discolored at the time of testing, causing a significant color difference from the original color.

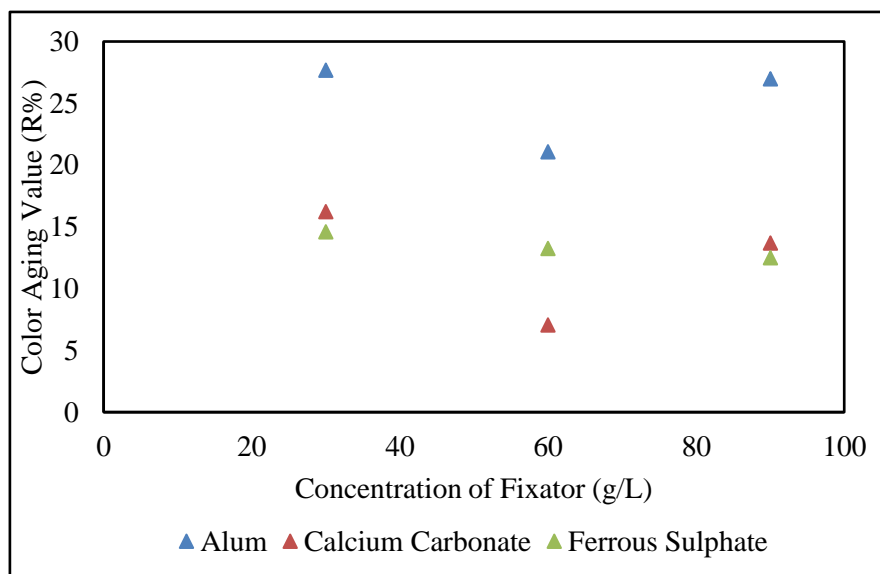


Figure 4. Graph of fixator concentration (g/L) versus color aging value (R%)

Color aging test aims to determine the amount of dye absorbed in the material. Measurements were made with a Spectrophotometer (UV-VIS PC). Retrieval of the value of R% is taken from one of the strongest R% number values, which is the last order range between the lowest 1-5. The smaller the value of R%, the color of the fabric is getting darker / darker. While the greater the value of R%, the color of the fabric is brighter or towards the color to white. Based on the data of the color aging test results, the fabric that has the smallest R% value is fabric fixed using a calcium oxide fixator at a

concentration of 60 g / L with an R% value of 7.06. While the fabric which has the highest R% value is the fabric which is fixed using alum fixator at a concentration of 30 g / L with an R% value of 27.70.

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4. Conclusion

According the result from the value of R% (color aging) and color fastness test against wet and dry rubbing, it can be concluded that alum and calcium oxide are the strong fixators and the optimal concentration is 60 g / L in dyeing batik fabric by natural dye of mahogany bark.

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