

Natural Colour from Plant for Fabric Dyeing

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Abstract—Natural dye has attracted the attention of the world due to its environment benefit and impact from usage of synthetic dye. In the present study, cotton and polyster (polysoft) fabric were dyed with three natural dyes derived from Malabar Melastoma (*Melastoma Malabathricum*), Fern (*Dicranopteris Linearis*), Tumeric (*Curucuma Longa. L*) using various natural mordants by three different mordanting method of dyeing. Pre-mordant and Meta-mordant give better results as compared to post-mordant method. Good washing and rubbing fastness with grey scale value higher than 3 was obtained for some mordants used. Post mordant gave light colour appearances. A tie and dyeing technique, through dotted, parallel line, spiral, and rectangular pattern was successful. Regular painting was not suitable to be used for natural dye due to dye spreading effect.

Keywords— *Natural Dye, Melastoma Malabathricum, Dicranopteris Linearis, Curucuma Longa. L, Natural Mordant, Tie and Dyeing.*

I. INTRODUCTION

Dyeing is process of colouring either to cloth, food, or any man made material in order to enhance or making thing attractive and pleasant to be bought. The various kind of property contain in synthetic dye such as moderate washes and resist to light fastness, high cost of natural dye, potential to produce low cost material, and advance in production of synthetic dye has led to completely change of usage from natural dye to synthetic dye after (Samanta & Agarwal, 2009). However, synthetic dye causes significant amount of impact on environmental and human. It is estimate that about 10^6 tons of synthetic dye being produces annually in the world, while 1×10^5 tons to 1.5×10^5 tons of synthetic is discharge into wastewater and polluting the environment (Pereira, L. & Alves, M. 2012, As cited in zollinger 1987). The polluted river containing synthetic dye can affect living organism and creature inside it. Referring to Zaharia, C. & Suteu, D. (2012), synthetic dye normally contains mixture of variety of pollution such as acids, bases, heavy metals, salts, surfactants, suspended solids and dyes. Chemical from synthetic dye reducing light to passing through water thus disturbing photosynthetic activity of aquatic plant reducing food of aquatic animal. Tiny layer may form above the water hence reducing the amount of oxygen that can be dissolved by water (Pereira, L. & Alves, M., 2012).

The more serious cases are that dye also effect to human such as carcinogenic, toxicity, and mutagenic activities (Liu, F. et al, 2016). Worker that are exposed too long to some chemical in hair dye have a probability to risk themselves to carcinogenic effect but this have not proven for personal user of hair dye (IARC,2010).

The literature survey indicates that there is hardly any work reported in the field of dyeing of cotton and polyster with natural dyes. The present study was undertaken to find the most suitable mordant method for dyeing using selected natural dye such as Malabar Melastoma (*Melastoma Malabathricum*), Fern (*Dicranopteris Linearis*), Tumeric (*Curucuma Longa. L*). Three type of mordanting method is used which is pre-mordant, meta-

mordant, post-mordant with different type of result appear for each mordant with respect to the natural dye used. In this research, temperature, pressure, method of dyeing, concentration of natural mordant used, and concentration of natural dye is kept constant. The tie and dyeing of batik dyeing is performed to test the suitability of extracted dye to fabric. The main purpose of this research is to:

- Extract and find green method of dye extraction from several plant.
- Test the characteristic of dye, produce from several plant on fabric.
- Perform the batik dyeing using natural dye produced.

II. METHODOLOGY

A. Materials

A 100 % cotton, and 100% polyster fabric, was used for dyeing. Detergent was used for washing fastness test. Methanol and distilled water used for extraction. The sources of natural dyes were obtaining from nearest plantation. Malabar Melastoma (*Melastoma Malabathricum*), Fern (*Dicranopteris Linearis*), and Tumeric (*Curucuma Longa. L*) stem, root, leaves, petal flower and fruit was used initially to determine part that produce natural colour. Method of dyeing was open bath dyeing.

B. Extraction of Dye

Melastoma Malabar (*Melastoma Malabathricum*) Dye

A ratio of 1:50 of 1 g Melastoma Malabathricum fruit to 50 ml distilled water is used. The solution is heated at 80 °C for 1 hour or more until the colour of natural dye become deep and then filter. The filtrate is ready for use.

Fern (*Dicranopteris Linearis*) Dye

1:10 ratio of 1 g Dicranopteris Linearis leaves to 10 ml methanol were prepared. The solution is then heated at 60°C about 30 minutes or more to extract the natural green dye from its leaves. After the solution turn dark green in colour. Filter its residue and the natural dye solution ready to be use for dyeing.

Tumeric (*Curucuma Longa. L*) Dye

Prepare a ratio of 1:50 of 1 g Curucuma Longa.L root to 50 ml of water and boil with 80°C temperature for 1 hour or more until the colour of natural dye has appear. Ensure the solution is in uniform stirring through the experiment. Filter the solution to remove residue and the solution then ready to be used for dyeing.

C. Mordant

Type of Mordant

Table 1: Procedure to Produce to Mordant Solution.

Mordant type	Procedure
Wood ash	15g of wood diluted with 750 ml of distilled water at 60 °C for 30 minutes.
Alum	10g of alum diluted with 500 ml of distilled water at 60 °C for 30 minutes.
Vinegar	100% purity is used.

Salt	15g of wood diluted with 500 ml of distilled water at 60 °C for 30 minutes.
Baking soda	15g of wood diluted with 500 ml of distilled water at 60 °C for 30 minutes.

Mordanting method

- Pre-mordant

A fabric was initially immersed in solution of mordant and heated until boil for 15 minute. The fabric was taken out and excess mordant was removed from fabric and proceed with dyeing section.

- Meta-mordant

1:10 ratio of mordant to natural dye was used. A fabric was ready for dyeing by using the prepared solution.

- Post-mordant

The fabric initially proceeds with dyeing. After dyeing process, the fabric was soaked into mordant solution for 15 minute. The fabric was then taken out and washed.

D. Dyeing

The dyeing method used is open bath dyeing. A natural dye solution is prepared in 250 ml beaker. A 150 ml of dye bath is prepared. A piece of cotton and polysoft fabric that cut at 5 cm x 5 cm is used for dyeing. The fabric was left for dyeing for about 30 minutes with uniform stirring at 80 °C. For Dicranopteris Linearis temperature for heating cannot be exceed 60 °C in order to prevent the green natural dye change to brown colour.

E. Color Measurement

The various colour change after water fastness test, rubbing fastness test, and washing fastness test were evaluated using grey scale for colour change. Initially the water test, washing test and rubbing test were done for 30 minutes and the sample evaluate using grey scale.

F. Batik Dyeing

Tie and dyeing was performed by using rubber band and cotton fabric that cut at 30 cm x 30 cm. The pattern that test is like spiral, dotted, parallel line, and rectangular pattern. Regular painting method also tried for the dye produce.

III. RESULTS AND DISCUSSION

A. pH of Natural Mordant and Solution

pH of every solution use is recorded due to the produce of different colour by different pH when its being mix in natural dye solution. The distilled water in Malaysia was 5.12 or acidic. Baking soda and wood ash show high pH value or acidic solution.

Table 2: pH of solution in the experiment.

solution	PH	Denomination
vinegar	2.63	Ultra acidic
alum	3.78	Extremely acidic
salt	4.83	Very strong acidic
Distilled water	5.12	Strong acidic
Baking soda	8.15	Moderately alkaline
Wood ash	8.72	Strongly alkaline

B. Natural Colour

Not all part produce colour, for an example flower petal from Melastoma Malabtricum may look purple once its extract with water it will produce colourless liquid. However, this purple colour from petal still can be extract by using alcohol extraction. Dicranopteris Linearis tend to produce brown solution when heated higher than 60 °C. Table 3 show the part of plant that have been extracted from this research and produce a natural.

Table 3: Part of Plant that produce Colour.

Plant Part	Type of Plant		
	Melastoma Malabtricum	Curucuma Longa. L	Dicranopteris Linearis
Root	-	√	-
Stem	-	-	-
Flower	-	-	-
Fruit	√	-	-
Leaves	-	-	√



Figure 1: Part of Plant That Produce Dyes.

Figure 3, 4, and 5 show colour produce when different type of mordant mix with natural dye while figure 2 show natural colour extracted without addition of mordant. All of the natural dye from figure below is diluted to view its colour.

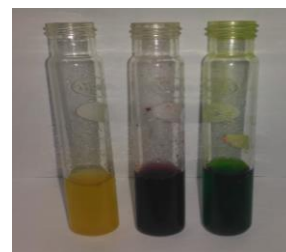


Figure 2: Natural Dye Colour Without Addition of Mordant. (From Left Curucuma Longa. L, Melastoma Malabtricum, and Dicranopteris Linearis Without Mordant).

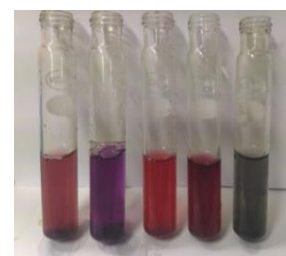


Figure 3: Natural Dye Colour Produce from Melastoma Malabtricum with Mordant. (From Left Wood Ash, Aluminium Sulfate, Vinegar, Salt, And Sodium Bicarbonate)

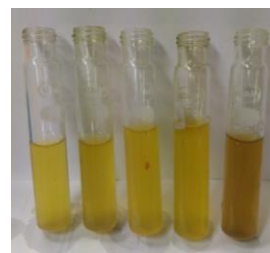


Figure 4: Natural Dye Colour Produce from Curucuma Longa. L with Mordant. (From Left Wood Ash, Aluminium Sulfate, Vinegar, Salt, And Sodium Bicarbonate)

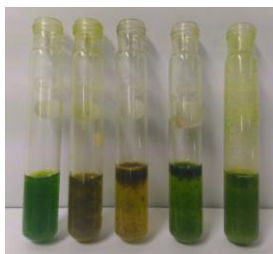


Figure 5: Natural Dye Colour Produce from Dicranopteris Linearis with Mordant. (From Left Wood Ash, Aluminium Sulfate, Vinegar, Salt, And Sodium Bicarbonate)

C. Dyeing Sample

For polysoft fabric Melastoma Malabtricum show suitable method by meta-mordanting with vinegar as a mordanting agent while for cotton fabric method suitable is pre-mordant and meta-mordant show suitable with alum (aluminum sulfate) as a mordant. Dicranopteris Linearis show better colour sticking on polysoft fabric by using post mordant method with wood ash a mordant and for cotton fabric, pre-mordant is suitable with alum. Curucuma Longa. L is suitable in pre-mordant and meta-mordant method in both fabrics tested. All mordant are suitable except for baking soda in Curucuma Longa. L which cause natural dye not binding to fabric. The different method is tested which is pre-mordant method, meta-mordant method, and post-mordant method. Without using mordant, only Curucuma Longa. L extracted dye bind to the fabric while the other cannot bind well. Pre-mordant method and meta-mordant method is most favorable by natural dye, whereas post mordant give light colour result appearances. Table below show sample cotton fabric after dyed with natural dye by meta-mordanting method.

Table 4: Cotton Fabric Dyed by Using Meta-Mordanting Method.

Mordant type	Type of plant		
	Melastoma Malabtricum	Dicranopteris Linearis	Curucuma Longa. L
Vinegar			
Sodium bicarbonate			
Alum			
Salt			
Wood ash			

Table 5: Polysoft Fabric Dyed by Using Meta-Mordanting Method.

Mordant type	Type of plant		
	Melastoma Malabtricum	Dicranopteris Linearis	Curucuma Longa. L
Vinegar			
Sodium bicarbonate			
Alum			
Salt			

Wood ash					
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D. Grey Scale for Colouring Value.

Curucuma Longa. L show better natural dye for sticking with fabric compared to Dicranopteris Linearis and Melastoma Malabtricum. The colour produce from Curucuma Longa. L show deep yellow colour almost identical with synthetic dye while Dicranopteris Linearis and Melastoma Malabtricum gave light colour tones.

Table 6: Grey Scale Colouring Value for Cotton Fabric

Mordant method	Type of plant	Type of Mordant				
		Wood Ash	Alum	Vinegar	Salt	Baking Soda
Without mordant	Melastoma Malabtricum	3.5				
	Dicranopteris Linearis	4				
	Curucuma Longa. L	3.5				
Pre-mordant	Melastoma Malabtricum	3	4	2.5	2.5	3
	Dicranopteris Linearis	2.5	4.5	2	2.5	3
	Curucuma Longa. L	3.5	4	4.5	4.5	1.5
Meta-mordant	Melastoma Malabtricum	2.5	3	2	4	1
	Dicranopteris Linearis	2.5	3	2.5	3.5	2.5
	Curucuma Longa. L	3.5	4	3	3	3
Post-mordant	Melastoma Malabtricum	4.5	4.5	4	4	3.5
	Dicranopteris Linearis	4	4	5	5	3.5
	Curucuma Longa. L	4.5	4.5	4.5	4.5	5

E. Grey Scale for Staining Value.

Table 7: Grey Scale Staining Value for Polysoft Fabric

Mordant method	Type of plant	Type of Mordant				
		Wood Ash	Alum	Vinegar	Salt	Baking Soda
Without mordant	Melastoma Malabtricum	1				
	Dicranopteris Linearis	2				
	Curucuma Longa. L	1.5				
Pre-mordant	Melastoma Malabtricum	3	3	1	2	4
	Dicranopteris Linearis	1.5	2.5	2	1.5	2
	Curucuma Longa. L	3	3.5	3	4	4
Meta-mordant	Melastoma Malabtricum	2.5	2.5	2	4.5	3
	Dicranopteris Linearis	2	2.5	2	1	2.5
	Curucuma Longa. L	3	4	3	5	4
Post-mordant	Melastoma Malabtricum	4.5	2.5	2.5	2	2.5
	Dicranopteris Linearis	4	5	4	3	3

	Curucuma Longa. L	3	4.5	5	4	4.5
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F. Batik Dyeing Technique

The batik painting was performed. Regular painting is tried, however the colour spread too fast making the natural dye not compatible to dye with this method. Tie and dyeing method is success making different abstract and pattern. Figure below show successful batik with dotted, parallel line, repeated rectangular, and spiral.

Tie and Dyeing (Ikat) Technique

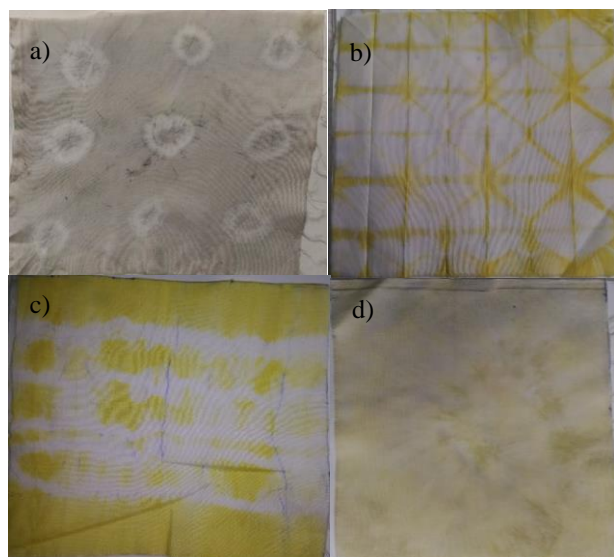


Figure 6: a) Dotted Pattern Using Melastoma Malabtricum. B) Uniform Rectangular Pattern by Using Curucuma Longa. L. C) Parallel Patern by Using Kunyit. D) Spiral Pattern by Using Melastoma Malabtricum, Dicranopteris Linearis, and Curucuma Longa. L.

Regular Painting Method

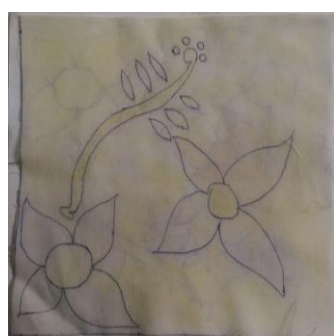


Figure 7: Regular Painting Method by Using Melastoma Malabtricum, Dicranopteris Linearis, and Curucuma Longa. L.

IV. CONCLUSION

From this research it can conclude that:

- Melastoma Malabtricum dye can be extracted from its fruits, Curucuma Longa.L from its roots, and Dicranopteris Linearis from its leaves.
- Pre-mordant method and meta-mordant method show deep colour appearance while post-mordanting method gave light colour appearances.
- Melastoma Malabtricum gave purple colour dye, Curucuma Longa.L gave yellow dye, and Dicranopteris Linearis gave green dye. Each mordant have different pH

which causes different colour produce when mix with natural dye.

- Dye from Melastoma Malabtricum and Curucuma Longa.L was successful to be extracted with water whereas dye from Dicranopteris Linearis cannot be extract using water.
- Some of the sample tested for fastness gave value higher than 3 which is acceptable to be commercializes.
- The Tie and Dyeing was successful dyed using natural dye produced and regular painting was not suitable to be used for dyeing.

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