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The Utilization Of Kudo Bark (*Lannea coromandelica*) As The Source Of Natural Dye In Dyeing Of Silk Batik

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Abstract : Exploration of various types of plants that are the largest source of natural dyes has begun to developed. Study on the utilization of Kudo (Lannea coromandelica) as a natural dye for silk batik had been conducted. Extraction of natural dye was carried out using water with a temperature at 100 °C. The coloration was applied to silk batik at both acidic (pH 4) and basic (pH 10) conditions using alum and ferrous sulfate as the mordants. The results indicated that kudo bark has the potential to be used as a source of natural dyes for silk batik. The highest color strength was obtained by using kudo bark extract under basic condition with the presence of ferrous sulfate. The obtained color shades for acid conditions with ferrous sulfate fixative, acid conditions with alum fixative, base conditions with alum fixative and base conditions with ferrous sulfate fixative, were dark brown, light brown, beige, and reddish brown, respectively. The results of fastness properties of the dyed fabric were good (4-5).

Keywords: *batik, natural dye, kudo, silk*
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1. Introduction

Indonesian batik is a masterpiece of cultural heritage in humanity and has been recognized by United Nations Educational Scientific and Cultural Organization (UNESCO) in 2009. Currently, Indonesian batik Small and Medium Enterprises (SMEs) generally used natural dyes in dyeing process of batik. The immensity of Indonesia that has a diversity of specific crops is a potential natural resource for this country. Part of tropical plants such as roots, wood, bark, stems, leaves, flowers, seeds, sap and fruit have been used to produce natural dyes in batik. Variety of plant species in tropical has been used in beautifying Indonesian batik through the resulting color [3].

Kudo tree (*Lannea coromandelica*) or commonly called by the locals in different parts of Indonesia as Jaran wood (Java), Javanese wood (Sulawesi), Reo tree (Flores) is a softwood species and belongs to *Anacardiaceae* family and Lannea genus. Beaman, J.H (1986) in Reddy, A.K (2011) said that among the 40 members of the genus Lannea, only Kudo trees grow in tropical Asia. Its international name is Indian Ash [10].

In the bark of Kudo, it is contained flavonoid and terpenoid compounds, but no alkaloids and steroids were found [10]. Flavonoids are one of the metabolites that are known to be color carriers. Flavonoid compounds are a group of the largest phenol compounds found in nature. These compounds are the red, purple, blue and yellow carrier substances found in plants. With the content of flavonoids, kudo bark has the potential to be used as a source of natural dyes [11].

The use of kudo bark as natural dyes for textiles has been widely reported. Varenkar & Sellapam made kudo bark extract with the ratio of ingredients material : water (1 : 5) at 60 °C for 4-5 hours and produced a brownish red on textile dyeing [6]. The kudo bark extract also gives a light red colour if using tin fixation, as was done by Ravi Upadhyay & Mahendra Singh Choudhary [9].

This research aims to study the potential as well as to determine the quality of natural coloration of kudo on silk batik.

2. Materials And Methods

2.1 Materials and reagents

The materials employed were Kudo bark from Palu (Central Sulawesi), silk fabric, batik wax, Turkey Red Oil (TRO), distillated water, Sodium carbonate (Na_2CO_3), Acetic acid (CH_3COOH), alum ($Al_2(SO_4)_3.K_2SO_4.24H_2O$) and Ferrous sulfate ($(FeSO_4).7H_2O$).

2.2 Apparatus

The equipment used were natural dye stuff extractor, stirrer, dyeing bath, laboratory glassware, analytical scales, universal pH indicator, and tools for batik making and process were used in this work. Shimadzu 2401 UV-Vis Spectrophotometer (PC) S for color strength test and rotawash color fastness tester (Launder-O-meter) for color fastness to washing test.

2.3 Extraction of Dye

Kudo bark was extracted using aquadest in the weight ratio of 1:10 and boiled for 60 minutes. The extract solution and wood were separated by filtration and then the solution was cooled for 60 minutes before dyeing process.

2.3 Pre-Mordanting Process

The silk fabrics were macerated using mordant before dyeing process. Alum and sodium carbonate were added in hot water until completely dissolved. The mordant process was carried out at 80 °C for 60 minutes, and left for 12 hours at room temperature. Then, the fabrics were washed using water and dried at room temperature.

2.4 Dyeing Process

The dyeing was done repeatedly 6 times to ensure maximum absorption of dye. Each immersion is done for 15 minutes. The pH of dye solution give effects to the color result. In order to achieve an acid condition, a number of acetic acid was added to the dye solution. However, addition of sodium carbonate was conducted to make the dye solution turns basic (pH 10).

2.6 Fixation (Post Mordanting) Process

The process of fixation is done by immersing the dyed fabrics in 2 types of fixative solution, there were alum and ferrous sulfate for 2-4 minutes until evenly distributed, then poured, rinsed with water and dried.

3. Results

Table 1. Test Results of Color Fastness to Washing

acid-basic condition, fixative	Color strength (K/S)	Color fastness to washing	dE*ab (Color Shade)
acid, alum	0,06	4 (Good)	32,58
acid, ferrous sulfate	0,07	4 (Good)	43,45
base, alum	0,01	4-5 (Good)	16,61
base, ferrous sulfate	0,04	4-5 (Good)	63,6

4. Discussion

4.1 Color difference test (L, a, b) and Color Shade (dE*ab) value

In the color shade test, the L notation represents the reflected light that produces white, gray, and black acromatic color with a range of 0-100 values. The notation a denotes a red-green mixed chromatic color, with a + a (positive) value from 0 to +100 for red, and a -a (negative) value from 0 to -80 for green. Notation b denotes a blue-yellow mixed chromatic color, with a + b (positive) value from 0 to +70 for yellow and a -b (negative) value from 0 to -70 for blue. dE*ab value indicates the color shade between the standard fabric and the samples [4].

It can be seen in Table 1, dE*ab value on the dyeing in basic condition use ferrous sulfate fixative gives the highest value, 43,45. Treatment with different fixative materials gives different coloration result. Alum fixative creates brighter color and ferrous sulfate fixative creates the darker color [8].

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Figure 1. Silk Batik Dyeing using Kudo Bark

As shown in Figure 1, the fabric has been dyed with natural dyes and produces a brown color, either in acid or base. The obtained color shades for acid condition with ferrous sulfate fixative, acid condition with alum fixative, basic condition with alum fixative and basic condition with ferrous sulfate fixative, were dark brown, light brown, beige, and reddish brown, respectively.

4.2 Color Fastness to Washing Test

As shown in Table 1, the results of the color fastness to washing showed good quality on 4-5 scale. The gray scale within range 1-5 was used as the color change on fabrics, where 1 is poor and 5 is outstanding. This is because silk fibers that have protein-molecular structure have good binding power with natural dyes.

The addition of fixative materials (complex salts) is essential for increasing the dye resistance of natural dyes. The addition of fixative materials such as alum and ferrous sulfate will enlarge the dye molecules and make it difficult to get out from the pores of the fibers [5].

4.3 Color Strength Test (K/S)

The color strength test is performed to find out the amount of dyestuff absorbed by the fabric. K/S expressed the relative color strength of dyed fabrics and evaluated by the light reflectance technique using Kulbeka-Munk equation.

$$K/S = (1 - R)^2 / 2R \quad \text{.......} \quad (1)$$

K is the absorption coefficient, S is the scattering coefficient, and R is the decimal fraction of the reflectance of dyed fabric.

As shown in Table 1, the color strength value ranged from 0,01 to 0,07. The highest value is the sample of the dyeing on acidic conditions with ferrous sulfate fixative. It is because at the time of fixation using ferrous sulfate fixative, there is a reaction between polyflavonoid tannins from natural dye and Fe^{3+} from the fixative material of ferrous sulfate which produces complex salt. Ferrous sulfate mordant is well known for it's ability to form complex coordination bond and to chelate with the dye and interact with the fibers [7].

The reaction between tannins with Fe^{3+} metals in silk dyeing can be seen in Fig. 2 and Fig. 3.

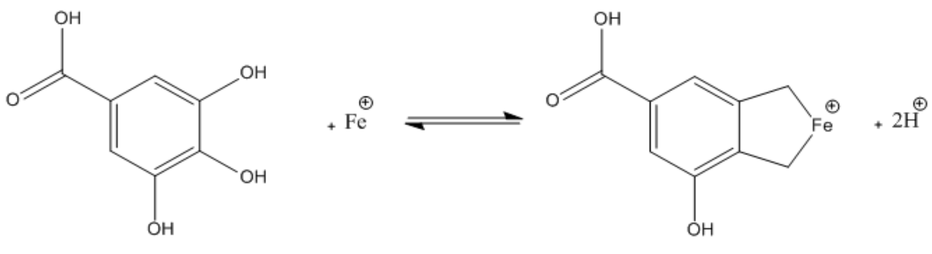

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Figure 2. Tannin reaction with Fe^{3+} from ferrous sulfate

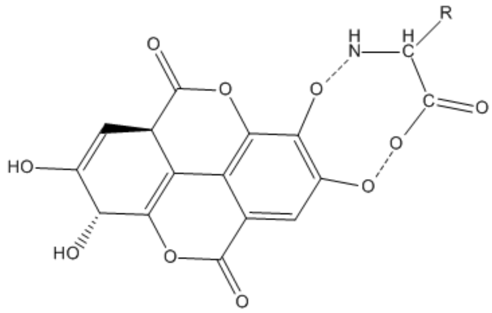

Figure 3. Reaction of protein (silk) petide chain with tannin

Silk fabrics can successfully dyed with natural dyes [1]. This may due to phenolic compounds of dyestuff component that can form hydrogen bonds with the carboxyl group of protein fibers. Furthermore, the anionic charge on the phenolic groups forms an ionic bond with cationics (amino group) on the protein subtrate.

The pH values of the dye have a considerable effect on the dyeability of silk fabrics while using natural dye. The effect of pH can be attributed to the correlation between dye structure and fabric. Since the dye used is soluble in water and containing -OH groups, it would interact with the protonated terminal amino groups of silk fibres at acidic pH via ion exchange reaction due to the acidic character of the -OH groups. The anion of the dye has complex characters, and when it is bound on the fibre, with ionic forces this ionic attraction would increase the dyeability of the fibre [2].

5. Conclusion

Based on the results, it can be concluded that Kudo bark was potential to be used as a source of natural dyes for silk batik. The obtained color shades for acid condition with ferrous sulfate fixative, acid condition with alum fixative, base condition with alum fixative and base condition with ferrous sulfate fixative, were dark brown, light brown, beige, and reddish brown, respectively. The test of fastness to washing towards coloration sample gave good quality on a scale of 4-5.

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