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Effect of Different Solvent on Tegeran (Cudrania javanensis) Wood Extract Dyeing Quality on Silk Batik

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Abstract: Tegeran (Cudrania javanensis) wood has been used as natural yellow dyes source for batik that traditionally obtained from extraction process by boiling in some amount of water. Tegeran dyes gives deep yellow color in cotton and silk batik with good fastness properties, but rarely reported about its result quality using different type of solvents in extracting process. Therefore, we conducted this research to find out how much different type of solvent in extracting process giving influence on dyeing result quality of silk batik. In this research has been carried out Tegeran wood extraction using four different solvent such as alcohol 70%, aquadest, acid/acetic acid solution pH 2.5 and alkaline/sodium hydroxide solution pH 12. The extract then used to dye batiked silk fabric. Tegeran wood extract coloring result in silk batik giving range colour from yellow to deep cream. The color strength values obtained were batik fabric dyed with Tegeran wood extract from alcohol 70% solvent 0.49, acid 0.57, aquadest 1.15, and alkaline 1.78. From color difference testing results, we obtain value of batik fabric colored with tegeran wood extract from alcohol 70 % L*=79.34, a*=6.37, b*=53.51; aquadest L*=87.91, a*=-0.69, b*=34.53; alkaline L*=76.06, a*=9.41, b*=14.76; and acid L*=77.70, a*=8.21, b*=36.72. The best solvent is sodium hydroxide pH 12 that brought deepest brown color and alcohol 70% that brought the lowest color degradation.

Keywords: Tegeran, batik, solvent, extraction

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1. Introduction

Tegeran wood has been used as natural yellow dyes source for batik along with other vegetable dyes Ceriopstagal (Perr.) C.B. Robinson (Soga tingi) bark and

Peltophorumpterocarpum (DC.) Backer ex K. Heyne (Soga jambal) wood to form soga color (Maimunah, 2012; Anastasia & Rum, 2014). Given latin name of Cudrania javanensis Trécul/Maclura javanica Blume/Cudrania cochinchinensis (Lour.)/Maclura cochinchinensis, and local name kayu kuning, tegeran spread out through South Asia (Himalayan Mountain, Nepal, India), East Asia (Japan), and South East Asia (Malayan Peninsula, Papua Island, Bismarck Island, New Caledonia, until East Australia) (SangatRoemantyo, 1991).

Tegeran wood as natural dyes traditionally obtained from extraction process by heating it in some amount of water. The heating was carried out until yellowish dark solution was obtained and ready to be used for dyeing batik. The color result in cotton and silk is yellow gold until yellow brown. Tegeran wood has been reported to contain flavonoid, alkaloid,steroid, saponin, also tannin (Swargiary & Ronghang, 2013). Based on Kongkiatpaiboon, et al. (2016) and Septhum, et al. (2007) report, the main flavonoid in Tegeran is morin.

Batik is handicraft made by resist dyeing using hot batik wax as resistant written by chanthing or stamp (Anonim, 2014). Natural dyes batik coloring process include fabric pretreatment, fabric dyeing and dyeing finishing (post mordant and batik wax removal). Fabric pretreatment is mordanting using metal salt alumuniumsulphate/tawas. Fabric mordanting step is carried out to give bridge between the dye and fabric, so that it can bond finely and increasing the color fastness properties (Vankar, 2000). After pre mordanting, the fabric is ready to be dyed. The dyeing process then finished with post mordanting using metal salt mordant and batik wax removal. Batik wax removed from the dyed batik fabric by soaking it in boiled water for certain time until all wax removed.

Tegeran wood as natural batik dye rarely used as single dye because its poor color fastness in hot water during batik wax removing process (Atika & Haerudin, 2013). In our previous research, tegeran wood was extracted using water solvent with temperature variation. The solution was acid and its dyeing fabric results's final color fastness properties was good (Atika & Salma, 2018). Tegeran natural dyes has also been studied for silk yarn dyeing with alum mordanting (Septhum, et al., 2007) and as nano emultion using tween 80 emulsifier for batik dyes (Herawati, dkk., 2012). All research giving good result for color fastness properties, but rarely reported about different solvent type for extracting process. Therefore, we conducted this research to find out how this is related with color shade result for batik dyeing.

2. Materials and Methods

The research were conducted by experimental method, with variation of extraction solvents such as ethanol 70%, acid solution/hydrochloric acid solution pH 2.5, aquadest, and alkaline solution/sodium hydroxide solution pH 12). The material used in this research were Tegeran wood (Cudrania javanensis) from Sulawesi, silk batiked fabric, aquadest, ethanol 70%,

hydrochloric acid, sodium hydroxide, sodium carbonate, alumunium sulphate, tapioca flour, and neutral detergent. The equipment used were extractor basin/waterbath, dyeing bath, electronic weight balance, batik wax removal set, and gas stove. The research were divided into 4 steps: dyes extraction, fabric dyeing (dyeing, post mordant, batik wax removal), batik fabric color testing, and data analysis.

Dyes extraction

Tegeran wood chips were boiled at 100ºC, each in acid solution, aquadest and alkaline solution. It was also macerated in ethanol 70% solution for 96 hours. Acid solution made by adding hydrochloric acid in aquadest until it reached pH 2.5, while alkaline solution made by adding sodium hydroxide in aquadest until it reached pH 12.The extract were filtered and the filtrate kept in closed bin.

Fabric dyeing

Silk batiked fabric were dyed using four dyeing solution under room temperature. The dyeing was carried out by soaking for 15 minutes then drying open air (not under direct sunlight). This process was repeated again until 6 times.

Post mordant usually called fixation using alumunium sulphate solution. Alumunium sulphate solution was made by boiling 70 g/l alumunium sulphate in water. The solution then let precipitate for one night before used for post mordant. Each fabric was soaked in the solution for 5 minutes, then dried in open air and wash thoroughly by clean water.

The post mordanted dyed batik fabrics were having wax removal process to clean it from wax. The batiked dyed fabrics were boiled in alkaline solution containing 10 g/l sodium carbonate, until all wax completely removed from the fabrics. The batik fabrics then dried open air and ready for testing. We called this with “batik fabric” term.

Fabric testing

Color strength and color difference measurement of samples is conducted using ultraviolet visible spectrophotometer. This measurement gives value of reflectance (R) that then converted empirically into color strength value (K/S) using Kubelka-Munk equation with assumption that there were no other factor interfered. K/S can be considered as the amount of dyes absorbed into the fabric (Kuntari & Barkasih, 2005).

$$\frac{K}{S} = \frac{(1-R)^2}{2R}$$

Where:

K = Light absorption coefficient

S = Light diffraction coefficient

R = Reflectance

Color difference measurement using CIELAB color space, based on lightness, chrome and hue. This three dimensional color space consist of three axis such as L* (lightness), a* (green – red), and b* (blue – yellow) (CIE, 1976). L* value is 0 = black and 100 = white, a* value is + = red and - = green, while b* value + means yellow and – means blue. Color difference can be obtained using following equation (Larrain, Schaefer, Reed, 2008).

$$\Delta E = \sqrt{\Delta L^2 + \Delta a^2 + \Delta b^2}$$

Where:

ΔE = Color difference
L = Lightness
a = Redness - Greenness
b = Yellowness - Blueness

3. Results

The silk batiked fabrics were dyed and the color shades results were gold, yellow, until brown, as seen in Table 1. Silk batik color testing results presented in Table 2 and Table 3.

Table 1. Tegeran wood extract dyeing result on silk batik

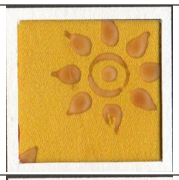
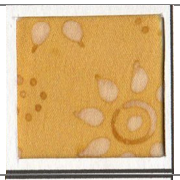
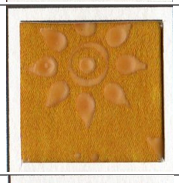
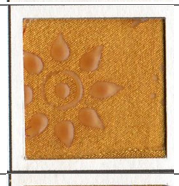
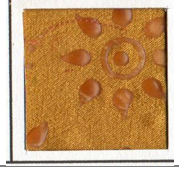
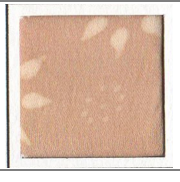
Samples	Before *Pelorodan*	After *Pelorodan*
Silk batik dyed with tegeran from alcohol 70% extraction		
Silk batik dyed with tegeran from aquadest extraction		
Silk batik dyed with tegeran from alkaline extraction		
Silk batik dyed with tegeran from acid extraction		

Table 2. Color strength testing results of samples before *pelorodan* process

Samples	%R	K/S
Silk batik dyed with tegeran from alcohol 70% extraction	38.33	0.49
Silk batik dyed with tegeran from aquadest extraction	25.10	1.12
Silk batik dyed with tegeran from alkaline extraction	18.58	1.78
Silk batik dyed with tegeran from acid extraction	35,97	0.57
Un-dyed silk	98.30	0.00

Table 3. Color difference testing results of samples

Samples	Before *Lorod*			After *Lorod*			ΔE^*_{Lab}
	L*	a*	b*	L*	a*	b*	
Silk batik dyed with tegeran from alcohol 70% extraction	72.42	9.08	65.09	70.46	11.00	48.82	16.50
Silk batik dyed with tegeran from aquadest extraction	56.89	17.62	57.24	83.44	2.27	44.23	33.31
Silk batik dyed with tegeran from alkaline extraction	61.05	17.29	51.98	69.79	15.14	35.32	18.95
Silk batik dyed with tegeran from acid extraction	57.13	17.34	49.77	70.73	12.59	19.68	33.35

4. Discussion

From Table 1, we can see the dyeing result with different extract solution from Tegeran wood. Dyed fabrics colors varies from gold to brown, while batik fabrics colors from yellow, pinkish brown to light brown.

Each solvent brought out different colors in the silk batik fabric. Tegeran wood has been reported contain flavonoids the source of yellow color, and tannin that can give brown color (Swargiary and Ronghang, 2013).

The color strength values range from 0.49 – 1.78. Batik fabric dyed with Tegeran wood extract from alcohol solution gave the lowest K/S value 0.49, followed by batik fabric dyed with Tegeran extracted from hydrochloric acid solution 0.57, batik fabric dyed with Tegeran extracted from aquadest 1.15, then the highest is batik fabric dyed with Tegeran extracted from sodium hydroxide solution 1.78.

Reflectance is defined as the ratio of the incident light to the reflected light or transmitted light (Clarke, 2006). Reflectance were converted into K/S color strength value. The higher the K/S value means more dyes were absorbed by the fabric. The deepest color were batik fabric dyed with Tegeran wood extracted in alkaline solution, followed by aquadest, acid and

alcohol. Batik fabric dyed with aqueous solvent extraction has absorbed more color than alcohol solvent. In aqueous solvent extract (aquadest, alkaline, acid), tannin were dominating the dyes because it tend to dissolve in water in relatively high temperature, ie 100ºC (Atika & Salma, 2017). Also there has been reported that alkaline solution increase the extractability of phenolic compounds of Tegeran wood (Sakagami, et al, 2013). Morin, the source of yellow pigment, were reported extracted by alcohol from Tegeran heartwood (Kongkiatpaiboon, 2017). Therefore, batik fabric dyed with Tegeran wood extract with alcohol 70% gave yellow gold color.

From color difference testing results, we obtain value of batik fabric colored with Tegeran wood extract from alcohol 70% solvent L*=79.34, a*=6.37, b*=53.51; aquadest L*=87.91, a*=-0.69, b*=34.53; alkaline L*=76.06, a*=9.41, b*=14.76; and acid L*=77.70, a*=8.21, b*=36.72. From the lightness values, batik fabric dyed with Tegeran wood extract from aquadest solvent gave the highest, followed by alcohol 70%, acid, alkaline. The highest redness value was obtained by batik fabric dyed with tegeran extract with alkaline solvent, followed by acid and alcohol 70%, except for aquadest solvent extraction dyeing result gave greener shade color.

The ΔE value range from 16.50 – 33.35. The less ΔE value means the least color degradation. The lowest ΔE obtained by dyed sample with extracted Tegeran wood dye with alcohol 70%, followed by alkaline, aquadest and acid solvents. It means the alcohol dyebath treatments give the lowest color degradation, followed by alkaline, aquadest and acid dyebath.

According to Septhum, et al. (2009), color absorbed by alum with pre-mordanted depending on solution acidity, initial concentration and dyeing bath temperature. Related to batik dyeing process, color quality depend also with batik wax removal, fabric type and mordant type (Atika& Salma, 2017). The initial concentration of dyes depending on chromospheres content and extraction condition. Extraction using alcohol 70% gave less color intensity but less color degradation. It may because alcohol 70% can make the dyes remain in the fabric during wax removal process. Water was less maintain the fabric color, because of the higher polarity that may broke the weaker bond between the dyes and the fabric. This become excess dyes that mended in fabric surface (Avinc, et al., 2013) and will be expelled during wax removal process.

5. Conclusions

Tegeran wood extract coloring result in silk batik giving range color from yellow to deep cream. The best solvent is alkaline dyebath solution that brought deepest brown color and alcohol 70% dyebath that brought the lowest color degradation.

6. Author Contributions

All the author have the same contribution in writing this paper.

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