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APPLICATION OF ENVIRONMENTALLY FRIENDLY NATURAL DYES FROM STEMS OF PLANTAIN (MUSA SAPIENTUM), KEPOK BANANA (MUSA ACUMINATA) AND THIN SKIN BANANA (MUSA ACUMINATA RED DACCA) ON BATIK FABRICS

Aplikasi Zat Warna Alami Ramah Lingkungan dari Batang Pisang Raja (Musa sapientum), Pisang Kepok (Musa acuminata) dan Pisang Kulit Tipis (Musa acuminata red dacca) pada Kain Batik

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ABSTRACT

Banana trees that are used as natural dye sources are plantain, thin skin banana, and kepok banana. The purpose of this study is to apply natural dyes from various types of banana stems such as plantain,kepok banana and thin skin banana on batik fabric with various fixator. The manufacture of natural dyes is conducted with banana stems and solvent water with a ratio of 1: 5. The fixators used are alum (Al2 (SO4) 3), *tunjung* (FeSO4) and lime (CaCO3).Fabrics that have optimal Color Fastness to washing measured with gray scale are fabrics with alum and lime fixators with a value of 5 (Very good). A fabric that has good color fastness to washing (Staining Scale) is a fabric with an alum fixator with a value of 4-5 (Good). Fabrics that have good Color fastness to dry rubbing and wet rubbing are fabrics with a fixator of alum and lime with a value of 4-5 (Good). The dye of the plantain stems with the lime fixator is brighter than the stems of both kepok banana and thin skin banana, with a reflectance (R%) value of 74.29 and a K/S value of 0.0445. The dye of plantain stems with *tunjung* fixator is darker than that of kepok banana stems and thin skin banana stems, with a reflectance value (R%) of 25.69 and a K/S value of 1.0747.

ABSTRAK

Pohon pisang yang digunakan sebagai penghasil zat warna alami adalah pisang raja, pisang kulit tipis, dan pisang kepok. Tujuan penelitian ini adalah mengaplikasi zat pewarna alami dari berbagai jenis batang pisang seperti Pisang Raja,Pisang Kepok,dan Pisang Kulit Tipis dengan berbagai pengunci zat warna alami.Pembuatan zat warna alami menggunakan batang pisang dan pelarut air dengan perbandingan 1: 5.Penguncian warna pada kain menggunakan beberapa fiksator. Fiksator yang digunakan adalah tawas ($Al_2(SO_4)_3$), tunjung($FeSO_4$) dan kapur ($CaCO_3$). Kain yang mempunyai ketahanan luntur yang optimal terhadap pencucian diukur dengan gray scale *adalah kain dengan fiksator tawas dan kapur dengan nilai 5 (baik sekali). Kain yang memiliki tahan luntur warna terhadap pencucian diukur dengan staining scale yang baik adalah kain dengan fiksator tawas dengan nilai 4-5*

(Baik). Kain yang memiliki ketahanan terhadap gosokan kering dan basah yang baik adalah kain dengan fiksator tawas dan kapur dengan nilai 4-5 (Baik). Zat warna pada batang pisang raja dengan fiksator kapur lebih terang dibandingkan dengan batang pisang kepok maupun batang pisang kulit tipis, dengan nilai reflektansi (R%) sebesar 74,29 dan nilai K/S sebesar 0,0445.Zat warna pada batang pisang raja dengan fiksator tunjung lebih tua dibanding dengan batang pisang kepok maupun batang pisang kulit tipis, dengan nilai reflektansi (R%) sebesar 25,69 dan nilai K/S sebesar 1,0747.

INTRODUCTION

Color is one of the main attractions and becomes an important criterion for the acceptance of products such as textiles, cosmetics, food, and others (Rymbai et al., 2011). Dyes are needed to add artistic value and used in varying a product (Satria, 2013).

In the beginning, batik artisans colored batik with natural dyes from various plant skins, fruits, or leaves (Suarsa et al., 2011). Natural dyes have the advantage of being environmentally friendly (Yernisa & dan Khaswar Syamsu, 2013). It generally obtained from the extracts of various parts of plants such as roots, wood, leaves, seeds or flowers (Susanto, 1973).

One of Indonesia's wealth that can be used as natural dyes is banana (A. A. Bawa Putra, N. W. Bogoriani, N. P. Diantariani, 2014). Banana plants consist of flower, fruit, skin, leave, tuber, and banana stem. The part of a banana plant that can be used for textile dyes is the stem (Suarsa et al., 2011). Banana stems contain several types of secondary metabolites, namely saponins, then flavonoids and tannins (Priosoeryanto et al., 2006). With this content, banana stems can be extracted into natural dyes for batik and textile fabrics. The manufacture of dyes and fixation of natural dyes of *rhizopora stylosa*, *mahogany* and *indigofera* has been carried out and tested with the results of increasing production from 57.5m^2 fabric / day to 121.9 m^2 fabric/day, minimizing the loss of dyes and fixators from 147.82 mL / m^2 fabric to 111.30 mL / m^2 fabric (Paryanto, Rivaldo Zamara, 2014). Intake of natural dyes from the mangrove fruit of *Rhizopora mucronate* species by extraction of solid-liquid three-stage batches on a pilot plant scale, produces tannins of 1662 ppm with an extract volume of 5.23 Liters. (Paryanto, Rivaldo Zamara, 2014). Production and application of natural dyes from mahogany bark, bark high for batik has been done with the results of the comparison of materials with water is 1:10, while the sharpest amount of dyeing obtained 10 times both dyeing for mahogany bark and high bark. (Paryanto & Nurcahyanti, 2018). The purpose of this study is to apply natural dyes from various types of banana stems such as plantain (*Musa sapientum*), kepok banana (*Musa acuminata*) and thin skin banana *(Musa acuminata red dacca*) on batik fabric with various fixator.

METHODOLOGY

Material and Tools

Materials used were plantain stem *(Musa sapientum)*, kepok banana *(Musa acuminata)* and thin skin banana *(Musa acuminata red dacca)* obtained from the Village of Demangan, Kepek Klaten, Central Java. Cotton fabric (primissima) obtained from the Solo Wholesale Center, Fixator in the form of lime, alum and *tunjung*/lotus obtained from Santosa Pasar Klewer Surakarta shop. Water that has been cooled for use as a cooler. The tools used in this study were extractor-evaporator and dyeing equipment.

Extraction Process

Extraction process is the process of taking color pigments contained in the leaves, stems, fruits, flowers, seeds and roots (Lemmens, R.H.M.J ,Wuliyarni-Sucipto, 1992). This process needs to be adjusted to the weight of the material that is going to be dyed so that the amount of natural dye solution produced can be sufficient to dye the textile material (Kartikasari & Susiati, 2016). The amount of solvent required depends on the amount of natural dye stuff that is going to be processed. The ratio of solvents and ingredients used is 5:1. Banana stems are cut into small sizes, then dried in the sun for 1 day. Cut the banana stems (weighed 1 kg) and put it in the extractor-evaporator. Add 5 L of water; as a solvent for extraction process. This process conducted for 1 hour at 100ºC followed by evaporation for ± 45 minutes. From this process a ± 4 liter dye was obtained.

Dyeing Process

The dyeing process using banana stem dye produces a brown color after it is applied to the fabric. The coloring process using dyes from the plantain stem, thin peeled banana and kepok banana were conducted by soaking the fabrics for 10 minutes with 10 times dipping repetition. The purpose of soaking for 10 minutes so that the dye can be absorbed more optimally and the resulting color is more concentrated.

Color Fixation Process

Fixation (color locking) is the process of strengthening colors so they don't fade easily (Rini, Sugiarti, & Riswati, 2011). This is done by dipping the colored fabric into the fixator solution (locking). After dyeing 10 times, sharper colors were produced. The sequence of dyes that produces the sharpest coloring is the banana stem kepok (*Musa sapientum*), plantain (*Musa acuminate),* and thin banana peels (*Musa acuminata red dacca)*. The process of fixation (locking); carried out by using three types of fixator / locking on each type of banana obtained the most optimal color sequence, namely fixation with *tunjung*, lime and alum (Amalia & Akhtamimi, 2016).

Dyeing Characterization of Batik Fabric

The characterization of the dyes from plantain stems, thin skin banana and kepok banana on premissima cloth was measured using *gray scale* (GS / CD) and *stainning scale* (SS / CD) with the testing method refers to SNI ISO 105-C06-2010, SNI ISO 105- E04: 2015,and SNI ISO 105- X12: 2012.

RESULTS AND DISCUSSION

The testing results of natural dyes on batik fabric and fabric can be seen in Table 3 for the results of color fastness to washing with *gray scale* (GS / CD) (SNI ISO 105–C06.2010). The results of fabric testing for staining with *stainning scale* (SS / CD) can be seen in Table 4 (SNI ISO 105–E04.2015). The results of the color fastness test against dry and wet rubbing are in Table 5 and Table 6 (SNI ISO 105–X12.2012).

Table 1. Pictures of Colored fabric without fixator

Musa acuminata	*Musa sapientum*	*Musa acuminata red dacca*
		

Table 1 shows the color of the fabric dipped in the stems of plantain, kepok banana, and thin skin banana without fixator.The appearance of brown on the stems of plantain, kepok banana and thin skin is caused by the tannin content in the stem of plantain banan, kepok banana and

thin skin banana.

Table 2 shows the darkest brown color of the fabric dipped in plantain stem, kepok banana, and thin banana with a *tunjung* or lotus fixator. Lime fixator showing the lightest brown color. This difference in color aging is due to differences in tannins. which is oxidized by the fixator. This is in line with the research conducted by (Amalia & Akhtamimi, 2016) which showed that the color of the fabric with natural dyes from rambutan rind using a *tunjung* fixator produces a dark brown color and with a lime fixator produces a faded light brown color.

Table 2. Pictures of Colored fabric with fixation

Dyes	Fixation Agent		
	Alum	Lime	Lotus
M. Acumi-nata			
M. Sapien-tum			
M.acu-minata red dacca			

Based on Table 3 the fabric fixed using alum and lime fixator has optimal fastness to washing analyzed with gray scale. *Tunjung*/lotus fixators have fairly good fastness while fabric without fixation has a low fastness, due to color changes during testing, causing a significant color difference from the original color.

Table 3. Color Fastness to washing (gray scale)

Dyes	Fixation Agent			
	Without fixation agent	Alum	Lime	Lotus
M. Acuminata	4-5	5	5	4-5
M. Sapientum	4-5	5	5	4
M. acuminata red dacca	4-5	5	5	4-5

Based on Table 4, the results of the analysis of color fastness resistance to staining with the Staining Scale, the fabric that has optimal color fastness without a fixator on the stems of kepok banana has a value of 4-5 (good). Fabrics fixed using an alum fixator have the same value in all dyes it has a value of 4-5 (good). Fabrics that have optimal color fastness using a lime fixator on the kepok banana dye have a value of 4-5 (good). Fabric that has optimal color fastness using a *tunjung* fixator on thin skin banana dye has a value of 4 (good).

Table 4. Color fastness to staining scale (Staining Scale)

Dyes	Fixation Agent			
	Without fixation agent	Alum	Lime	Lotus
M. acuminata	4-5	4-5	4-5	3
M. sapientum	3	4-5	4	3-4
M. acuminata red dacca	4	4-5	4	4

Table 5. Color fastness to dry rubbing

Dyes	Fixation Agent			
	Without fixation agent	Alum	Lime	Lotus
M. acuminata	3	4-5	4-5	3-4
M. sapientum	2-3	4-5	4-5	3-4
M. acuminata red dacca	2-3	4-5	4-5	3-4

Tables 6. Color Fastness Test Results against Wet Rubbing

Dyes	Fixation Agent			
	Without fixation agent	Alum	Lime	Lotus
M. acuminata	4-5	4-5	4-5	4
M. sapientum	3-4	4-5	4-5	4
M. acuminata red dacca	4	4-5	4-5	4

The color fastness test to dry rubbing is intended to determine the staining of the colored fabric on other fabric caused by rubbing. From the results of the analysis of the color fastness test to dry rubbing which is presented in Table 5, the three dyes get a value of 4-5 (Good), which are fabrics that are fixed using alum ($Al_2 (SO_4)_3$) fixator and lime (CaO) fixator, while the fabric that is fixed using a fixed fixator ($FeSO_4$) got a value of 3-4 (good enough). For fabrics without fixation, kepok banana stems have the best results among the others having a value of 3 (enough).

From the results of the analysis of the color fastness test against wet rubbing, which is presented in Table 6, the optimal fabric dyed with kepok banana stems, plantain stems and thin skin banana stems is fabric fixed using alum fixator ($Al_2(SO_4)_3$)and fabric fixed with a lime fixator (CaO) with a value of 4-5 (good) in all three dyes. Fabrics fixed with a *tunjung* fixator ($FeSO_4$) with a value of 4 (good) for all three dyes, while fabrics without a fixator with a good average value for the three dyes.

Color strenght test aims to determine the amount of dye absorbed in the material. Measurements were made with a fabric caused (UV-PC). Retrieving reflectance value (R%) is taken from one of the strongest reflectance number values(R%), which is the range of the last sequence between the lowest 1-5 (Hearle & Peters,2013). The smaller the reflectance value (R%), the color of the fabric is darker / darker, while the greater the reflectance value (R%), the color of the fabric is brighter or towards the color to white (Kuntari, 2006). The color aging test can also be done by converting the reflectance value into a K/S value. K/S assessment aims to represent the amount of dye fixed into the fiber. K/S is the ratio of color absorption to the dispersion coefficient of K/S calculated using the Kubelka-Munk equation, from the lowest R (reflectance) value measured using a spectrophotometer based on the Kubelka-Munk equation as follows. (Cica Kasipah, Eva Novarini, Emma Yuniar Rakhmatiara, 2015).

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

Information:
K = light absorption coefficient
S = light scattering coefficient
R =% reflectance

The greater the K/S value means the darker the color, while the smaller the K/S value means the lighter color.

Table 7. Fabric Color Test Results (Reflectance = R%)

Dyes	Fixation Agent			
	Without fixation agent	Alum	Lime	Lotus
	R%	R%	R%	R%
M. acuminata	44,66	42,99	49,70	30,44
M. sapientum	38,78	73,83	74,29	25,69
M. acuminate red dacca	42,24	68,26	56,94	39,03

Table 8. Data on conversion of R% value into K/S

Dyes	Fixation Agent			
	Without fixation agent	Alum	Lime	Lotus
	K/S	K/S	K/S	K/S
M. acuminata	0,3429	0,3780	0,2545	0,7948
M. sapientum	0,4832	0,0464	0,0445	1,0747
M. acuminate red dacca	0,3949	0,0738	0,1628	0,4762

Based on the data from the color aging test results shown in Table 7, the fabric that has the smallest reflectance value (R%) is the fiber that is dyed with plantain stem dye and fixed using a *tunjung* fixator with a reflectance value (R%) of 25.69. while the fabric that had the highest reflectance value (R%) was dyed with plantain stem dye and fixed using a lime fixator with a reflectance value (R%) of 74.29. Based on the data converted from the reflectance value (R%) to the K/S value using the Kubelka-Munk equation, the fabric that has the smallest K/S value is the fabric that is dyed with plantain stem dyes and fixed using a lime fixator with a K/S value is 0.0445, while the fabric that has the highest K/S value is the fabric dyed with plantain stem dyes and the *tunjung* fixator with a K/S value is 1,0747 so that the dye on the plantain stems with the *tunjung* fixator has a darker color than the banana stem dye,kepok,and thin skin banana stems. *Tunjung* gives a darker color direction because the Fe^{2+} ion contained in the *tunjung* oxidizes the tannins to a darker color, and the tannin content in the plantain stems is more than the kepok banana stem and the thin skin banana stem.

CONCLUSION AND SUGESSTION

Fabrics that have optimal Color Fastness to washing measured by gray scale are fabrics with alum and lime fixators with a value of 5 (Very good). A fabric that has good color fastness to staining scale (Staining Scale) which is a fabric with an alum fixator with a value of 4-5 (Good). Fabrics that have good color fastness to dry rubbing and wet rubbing are fabrics with a fixator of alum and lime with a value of 4-5 (Good). The dye of the plantain stems with the lime fixator was brighter than the stems of both the kepok banana and the thin skin banana, with a reflectance (R%) value of 74.29 and a K/S value of 0.0445. The dye on plantain stems with a *tunjung* fixator was darker than that of kepok banana stems and thin skin banana stems, with a reflectance value (R%) of 25.69 and a K/S value of 1.0747. The greater the K/S value, the darker the color or the greater the reflectance value (R%), the lighter the fabric color.

AUTHOR CONTRIBUTION

The main contributors of this paper are Paryanto and Sunu Herwi Pranolo,while the member contributor is Angga Dwi Wibowo.

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