Development and effects of naphthol dyes in the washing processes

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Abstract. This study aimed to: describe the value of color fastness to washing by using five types of detergent namely cream, powder, bar, liquid, and Sapindusrarak on Tan written batik cloth with naphthol dyes; determine the effect of the detergent types on the color fastness; and find out the best type of detergent according to its composition for washing batik with naphthol dyes. This was true experimental research with the AXB factorial design in which A is the Tan batik cloth, and B is the factor of washing treatment with five detergent types. To collect the data, the researchers employed the probability sampling technique, which is a simple random sampling technique. Also, they tested the color fastness in the washing processes carried out by the examining team at the Batik and Craft Center with procedures and calibrated tools. The data were analyzed using a non-parametric analysis, namely, a Kruskal-Wallis test. The color fastness test of Tan batik cloth washed using five types of detergent produces a good average value of 4-4.5. The result of the difference test on the color fastness to washing and staining is p 0.406 > 0.05. It means there is no significant difference because the detergents have the same composition, i.e., an anionic surfactant. The detergent with the best composition is Sapindusrarak, because it contains saponin as a natural surfactant. People can use detergents to wash batik by selecting the composition of lauryl alkyl benzene sulfonate as a soft substance.

1. Introduction
October 2, 2009 is a historic day for Indonesia because, at that time, the United Nations Educational, Scientific and Cultural Organization (UNESCO) recognized that batik is a masterpiece of the oral and intangible heritage of humanity [1]. The government issued Presidential Decree No. 33 the Year 2009 concerning "National Batik Day" on October 2. Batik is a heritage of the Indonesian ancestors who had a high "aesthetic value" [2]. Making crafts made of batik becomes a part of Nation culture and is regarded as an occupation. Batik requires special care, especially the written batik type because the treatment includes four processes, namely washing, storing, drying, and soaking [3].

Washing is one way to maintain the batik cloth because it is made and colored manually with no machine use. Before conducting research, the researchers observe that written batik is washed using a popular detergent in society. After the third washing, there is no significant change in color. The detergent sold in society varies, and it functions to reduce the surface tension, release dirt, and break impurities. Detergents contain high active buildersubstances, enzymes, bleach, and other supplementary compositions [4].

Manual batik washing can employ Sapindusrarak De Condole, or S. mukoros. This plant is known for its seeds, which can be used as traditional detergents and to maintain the batik quality in the wash. Its seed contains saponins and poisonous alkaloids. Saponins can produce foams and functions as a washing and cleaning agent for various household appliances. Batik does require
special washing chemicals or traditional substances. Also, saponins work as surfactants that make the washing water "wetter." As a result, saponins easily enter the washed fibers, bind to the attached dirt, and remove the dirt from the cloth [5].

Batik washing affects cloth durability. Previously, the first research on the effect of the batik washing frequency was conducted, but it only used one type of detergent, namely *Sapindusrarak*. The results of the variance analysis indicated a significant influence on the washing frequency of 1 to 7, showing the best color sharpness, and at the 9th to 19th washing, the color fading had occurred. The second research on the effectiveness of natural soap on the batik color showed that batik clothes washed using *Sapindusrarak* fruit and commercial liquid *Sapindusrarak* have the same value of 4 [6]. The first study produced significant results because it was washed 19 times; the second study had the same result, but how many times of washing was not informed in the study.

The research tests the batik color fastness using naphthol synthetic dyes by applying the washing treatments with five popular types of detergents popular in the community. The cloth used is *mori primissima* cotton; it has hygroscopic properties and absorbs colors well. The written batik was employed because this type is well known in the wider community and is quite popular in the international market, as seen from the batik exports increasing every year [7].

This color fastness test uses five types of detergent used by society to wash clothes. The detergent types are powder, liquid, cream, bar, and *Sapindusrarak* to help maintain the batik properly. This also intends to find out the detergent which has safe compositions, so it can be an alternative if people cannot find a *Sapindusrarak* detergent. Therefore, the discoloration in the washing process can be prevented.

2. Research Method

2.1. Methods

*Diagrammatic representation*

This was true experimental research that aimed to describe the value of the color fastness to the five types of detergents used in daily life and to investigate whether there are detergent effects on the Tan written batik color fastness. The experimental research used the AXB factorial design, where A is a test for color fastness to washing, and B is the factor of washing treatment with five detergent types, namely liquid, powder, *Sapindusrarak*, cream, and bar.

To collect the data, the researchers employed the probability sampling technique, which is a simple random sampling technique. Also, they tested the color fastness to washing carried out by the Examining Team at the Batik and Craft Center with procedures and calibrated tools. The data were analyzed using a descriptive analysis technique with a non-parametric analysis, namely, a Kruskal-Wallis test. The results of the difference test were in the form of ordinal data.

2.2. Equipment

2.2.1. Equipment and Materials

The equipment used in this study was a washing machine, analytical scale, ruler, scissors, buckets, gray scale, and staining scale. The ingredients included powder detergent with 19% anionic surfactant; commercial liquid *Sapindusrarak* and cream detergent with 18% sodium alkylbenzene sulfonate and 0.06% optical brightener; bar detergent with LAS active substance; liquid detergent with 16% surfactant, and 1.4% additive; written batik; white *mori primissima* cotton; powder, cream, liquid, and commercial liquid *Sapindusrarak* detergents.
2.2.2. Experimental Procedure

Washing Recipe

Washing of Naphthol dyed Written Batik

Vlot : 1: 40
Powder Detergent : 2 gr/liter
Temperature: Room Temperature

The experimental procedure can be seen in Figure 2; the preparation was carried out by preparing a test sample of batik and white cotton to test the color fastness and staining by cutting the fabric with a size of 50cm X 50cm, sewing it on one tip, weighing the test sample to determine the amount of soap and solvent needed. After that, wet the batik cloth with plain water, and then put it in the washing machine, pour water and powder detergent; the test sample is put in the machine for 5 minutes at a medium speed. After 5 minutes, the cloth is rinsed and dried in the shady and windy place. Wash the cloth three times; after dried, check the sample. Check whether there are any changes in the color of the colored fabric and stains on the white cloth. Measure the color changes with the gray scale, and for the color staining, use the staining scale.

Figure 1. Conceptual Framework
3. Result and Discussion

3.1. Result
The results of the color fastness testing of the written batik colored with naphthol dyes to washing using five types of detergents, namely liquid, bar, powder detergent, cream, Sapindusrarak can be seen in Table 1. The results of the normality test with SPSS are 0.001 < 0.05, which means that the data are not normally distributed; therefore, it is further tested with the One-Way Non-parametric ANAVA test or Kruskal Wallis test, which can be seen in Table 1. The data analysis with SPSS program shows the result of the color fastness testing to washing is $p > 0.05$; it can be seen in Table 2.

The data analysis with SPSS program shows the result of the color fastness to staining on a white cloth (*mori primissimacotton*) is $p > 0.05$; it can be seen in Table 3. Based on test results, the liquid, bar, cream, and powder detergents produce a whiter cloth than the previous one, since the surfactants contained in the detergent are made of chemicals, while for the Sapindusrarak detergent, the staining result has almost the same color as the original due to the surfactant oil which is not produced by chemicals but by the fruit itself.

| TEST TYPE | TEST RESULT |
|-----------|-------------|
| Color Fastness to Washing | DCr | DB | DL | DBt | DC |
| Value of Color Changing | 4 | 4-5 | 4 | 4 | 4 |
| Value of Cotton Color Staining | 4 | 4 | 4-5 | 4 | 4 |
Note: 1 = very poor, 1-2 = very poor, 2 = poor, 2-3 = poor, 3 = fair, 3-4 = fairly good, 4 = good, 4-5 = good, 5 = excellent

**Table 2.** Result of SPSS normality test with SPSS Program

| Test of Normality | Statistic | df | Sig | Statistic | df | Sig |
|-------------------|-----------|----|-----|-----------|----|-----|
| Lilliefors Significance Correction | .441 | 4 | . | 6.30 | 4 | .031 |

Note: a. Lilliefors Significance Correction
b. uji TLW Pencucian is constant when uji TLW Penodaan = 4.5. It has been omitted.

**Figure 3.** Washing Results with Five Detergent Types

**Table 3.** Statistical Results of Color Fastness Test to Washing with five detergent types

| Indicator | χ² Table | χ² Count | Asymp Sig | α 5% | Note |
|-----------|----------|----------|-----------|------|------|
| TLW Test Against Wash | 9.488 | 4.000 | 0.406 | 0.05 | No significant difference |

**Table 4.** Statistical Results of Color Fastness Test to Staining with five detergent types

| Indicator | χ² Table | χ² Count | Asymp Sig | α 5% | Note |
|-----------|----------|----------|-----------|------|------|
| TLW Test Against Staining | 9.488 | 4.000 | 0.406 | 0.05 | No significant difference |
3.2. Discussion

Washing with soap is intended to determine the color fastness to repeated washing [8]. Table 1 shows the washing result in the color fastness produces good average data. The results of the SPSS analysis in Tables 2 and 3 show that there is no significant difference in the value of washing written batik with napthol dyes by using five types of detergent, namely powder, liquid, cream, bar, and Sapindusrarak. The difference test result of the color fastness of the powder detergent is 4.5, cream detergent 4, liquid detergent 4, bar detergent 4, and Sapindusrarak detergent 4. Each has good average value.

The staining test result on the white cloth is shown in Table 4. It produces good average data, as described as follows. Cream detergent produces a value of 4, bar detergent 4, Sapindusrarak detergent 4.5, powder detergent 4, and liquid detergent 4. The powder detergent composition used in this study is 19% anionic surfactant. This is usually for domestic purposes because it is cheaper and more stable in water; it has good clean power and has much foam; functions as a wetting power, so fatty impurities can be moistened; removes dirt on the fabric and suspended dirt.

The composition of liquid detergent includes surfactant 16% and additive 1.4%. The function of surfactants in liquid detergents is the same as powder detergents’ because they are the main ingredient that produces foam and water wetting, so fat impurities can be wetted. Additives are additional substances in detergents, which are usually added a little. They are used as a removal material for a detergent product. This substance is added in a small quantity to improve the properties of a component in detergents. The composition of cream detergents is the active ingredient sodium alkylbenzene sulfonate 18% and optical brighter 0.06%. Alkylbenzene sulfonate is a type of anionic surfactant whose composition is almost the same as powder detergent’, which is a stable surfactant in water and has good washing power. This type of detergent is not recommended for washing batik, because ABS is contained in hard detergents due to the branched carbon chain. It contains active substances difficult to decompose by microorganisms, both before use and after disposal. It cannot be degraded; therefore, the substance is still active and pollutes the environment. The composition of bar detergent (LAS), which is included in the anionic surfactant category, is indeed used in commercial detergents. It has the same function as wetting water, so the fatty impurities can be wetted and easily removed. LAS is classified as a soft detergent because it has an unbranched carbon chain. In the market, it is often claimed with biodegradable surfactants, which are quickly broken down by microorganisms. The composition of Sapindusrarak detergents is the original fruit of the tree containing saponins. The substance produces foam, and functions as washing and cleaning agents.

Saponin is a surfactant that makes washing water "wetter"; consequently, saponins easily enter the washed fabric fibers, bind to the attached dirt, and remove the dirt. Therefore, this detergent is highly recommended for washing the written batik, because it does not contain chemicals but natural surfactants. The results of the color fastness test of written batik with naphthol dyes to washing by using five types of detergent show that there is no significant difference due to the same composition in each detergent, i.e., an anionic surfactant.

The naphthol color is a compound that is not soluble in water. As a result, in textiles, the color compound has the tendency of not coming out into the water when washed, or in other words, the color is resistant to washing. Then, naphthol is included in the dye with excellent color fastness [9]. Based on the color fastness to staining, the best detergent is Sapindusrarak (4.5). Compared to the other types of detergents, it has the best value in color fastness because of its natural composition. Therefore, its fruit is highly recommended for washing batik.
Regarding the detergent composition used in this study, before washing batik with detergent, it is crucial to pay attention to its composition, which contains lauryl alkylbenzene sulfonate, because it is biodegradable and widely spread on the market. Do not use detergents with a bleaching agent. However, detergent also should not be used too often in washing batik, even though the color fastness to chemicals or chemical reactivities in each type of fiber depends on the chemical structure and the active groups on fiber molecules [10]. Compared to the previous study with one type of detergent (Sapindusrarak), this study is more extensive by using five types of detergent. However, there was an advantage in the previous study, the washing was carried out up to 19 times, so there was a significant result; in this study, the cloth is only washed three times, so there is no effect caused.

4. Conclusion

The results of three washes using five types of detergent, namely liquid, powder, bar, cream, and Sapindusrarak, on average, show a value of 4-4.5, which means good. There is no significant effect of the washing and staining on the color fastness of written batik with naphthol dyes. It is proven with the statistical result (0.406 > 0.005), so naphthol dyes have good color fastness. The type of detergent with the best composition for washing batik is Sapindusrarak, because it contains saponin as a natural surfactant. The use of detergents with lauryl alkylbenzene sulfonate is recommended for washing batik because it is biodegradable and widely found in the market, but it is not suggested for repeated washing.

This study only uses one sample for each type of detergent. For further research, it is strongly recommended to try other types of detergent, because the level and composition for each type of detergent are different. Also, more than three washes need to be carried out to have a significant effect. Do repeated washing to obtain significant data.

This research can be developed through further research using the original fruit of Sapindusrarak to guarantee authenticity. Naphthol is a dye that has good color fastness and can be used to dye batik cloth. It has many color palettes used for coloring in the batik industry. Naphthol dyes are better than others. To reduce the impact on health when dyeing a piece of cloth with naphthol, it is necessary to pay attention to the operational standards and waste before disposal, one of which is by wearing a mask and rubber gloves.

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