International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2015): 78.96 | Impact Factor (2015): 6.391

Coconut Water as a Mordan on Natural Dyes Leather Made from Rambutan Skin for Silk Fabrics with Tie Dye Techniques

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Abstract: ***This research is an experimental research, which aims to know the benefit of coconut water as a mordan to simplify and enlarge the amount of dyestuff absorbed by silk fiber. It also has a function to increase the brightness of the color by using natural dye from rambutan skin with tie dye technique. In this experiment, we used about 500 grams of dried rambutan skin, 5 liters of water extracted into 2 1/2 liters of water, 1 liter of coconut water which has been kept for 24 hours, 500 grams Tawas with 10 litters of water as solvent, and 1 meter of silk fabric. Data were collected by using questionnaire and were given to 30 panelists. The results showed that coconut water can be used as a natural and environmental friendly mordan. There were about 90.83 % of panelist gave very good rate to the color of silk fabric in term of its cloth sheen, sharpness, flatness and cloth shrinkage tolerance. Therefore, the coconut water can be used as an alternative mordan solution and natural dye for textiles.***

Keywords: Coconut Water, Mordan, Rambutan skin, Tie Dye

1. Introduction

Silk fabric is a textile material that is very popular by people, especially in Indonesia. It is a material made of silk worm cotton thread. It has been categorized as a very good material as it is shiny, has soft textures, and is able to absorb water very well. It can be saide that silk fabric has a good tensile strength and good absorption. This nature is the main factor that make the silk fabric to be easily dipped and dyed. Therefore, in the staining process these characteristics are helpful for the absorption of the dyestuff.

The development of the textile industry has progressed rapidly, both on production and quality. The current variety of textile products uses more synthetic dyes, as they are easier to obtain and need less time to produce dyes than natural dyes. However, in many developed and developing countries the use of natural dyes has been developed and reused for textile dyeing considering their natural resources and facilities. The countries have many potentials to produce natural dyes in each part of plants such as leaf, bark, root, and sap. In Indonesia, one of the natural potential is rambutan plant. Its fruit skin can be used as a natural dye for textile because it contains anthocyanin pigment, chlorophyll, carotenoid, and water-soluble tannin that easily dissolved in water. It can then be utilized as a natural dye especially for the red colour.

Part of rambutan fruit that will be utilized as a natural dye is the skin of rambutan fruit that has been separated, dried and then extracted into a natural dye for textiles. The process of textile dyeing simply includes mordanting, staining, fixation, and drying. This study uses old coconut water, as a mordanting solution because coconut water contains electrolytes, chlorides, calcium, potassium, magnesium, sodium, and riboflavin [1].

Mordan dyeing process is a substance used to soak cloth or yarn before the coloring process is done. Mordanting is substances that help increase the brightness of the dye to the fiber [2]. In this study, coconut water was used as a mordan as it is easy to obtain and environmentally. The addition of electrolyte to the dye solution is to increase the amount of dyestuff absorbed by the fabric even though they have different adhesions [3].

Based on the above description, in this research, flatness of the color on the silk fabric and color decay after washing will be tested by standard test. So far no one uses coconut water as Mordan as well as the usual rambutan skin. They were only used as a dye on the manufacture of batik cloth, which has not been marketed extensively because of the manufacturing process that takes long time to produce the cloth. It was expected that the dyeing of fabrics using natural dye from the skin of rambutan by utilizing coconut water as mordan can enlarge the amount of dyestuff absorbed by the silk fabric.

In the last part of this research, several panelists were given questionnaire to get their opinion about the quality of silk cloth that has been immersed by natural dye made from rambutan skin and coconut water as mordan by using tie dye technique.

2. Research Method

2.1. Types of Research

This research is an experiment research that is more emphasized on the aspect of objective measurement of what is researched and the design of materials and tools. This study aims to know the result of using coconut water as mordan to facilitate the absorption of dyes on fabric fibers, and rambutan skin as a natural dye used in this study.

2.2. Design

Design is an illustration that will be made as the base in making clothing [4]. Pattern design that will be made is cow eye. The pattern is based on Henny Hasyim's manual titled Tie Dye [4]. Size of materials to be used for the dyeing process is 29 cm long and 24 cm wide fabric as much as 6 sheets.

Figure 1. Designed motif

The square parts in the silk were made by twisting the cloth from the midpoint in which a small stone was put on it. The stone was in almost square-shaped but is less spherical. It was bundled with a distance of 2cm each bond to the other in the cloth.

3. Tools and Materials

3.1 Tools

Tool to be used for dyeing:

1) The basin
2) Gloves
3) Scales
4) Scissors
5) Measure Glass.
6) Rope to tie the fabric
7) Pans are used for cooking cloth
8) Measurement band in cm
9) Iron
10) The stove is used to cook the fabric to be colored.
11) Clothes Clamp to clamp the fabric
12) Food Clamps for lifting cloth at the time of color dyeing process.

3.2 Materials

Materials used for the process dyeing:

1) Silk Fabrics used for coloring process.
2) Old coconut water as mordan
3) Dry Rambutan skin for the extract to be a natural dye
4) Tawas stone as solvent to lock the dyestuff after the silk cloth is dyed.
5) Water used for staining process.

3.3 Color Substances Making Process

The process of extracting or preparing a natural dye solution needs to be adjusted to the weight of the material to be processed so that the amount of natural dye solution produced can be sufficient to dye the textile material. The required amount of natural dye solution depends on the amount of textile material that is processed. The ratio of the dye solution to the commonly used textile is 1:30. For example, the weight of textile materials processed 100 grams then the need of natural dye solution is 3 liters. The following are the extraction process steps for natural dyes:

1) Cut desired plant parts into small size e.g.: rambutan skin. The material can be dried first or extracted directly. Take the piece weighing 500 gr.
2) Put the pieces in the pan. Add water with 1:10 ratio. For example, if the weight of the extracted material is 500 gr then the water is 5 liters.
3) Boil the material until water becomes half (2.5 liters). If the dye solution wants to be made more viscous volume, then the rest of boiling can be reduced for example to a third. As an indication that the color pigment present in the plant has come out is shown with water after the boiling becomes colored. If the solution remains clear then the plant almost certainly does not contain color pigments.
4) Filter water with the filter extract to separate the residue of the extracted material (residue). The extract solution of this filtration result is called the natural dye solution. After cooling, the solution is ready to use.

3.4 Preparing Immersion with Natural Substances

Before dyeing with the natural dye on cotton and silk fabrics, some preparation process has to be done [2]. Textile materials to be colored must pass mordating processed first. This process is intended to increase the appeal of natural dyes to textile materials as well as useful to produce adhesion and good sharpness of good color [2]. Mordan substance acts as a substance that helps improve the brightness dye to fiber. Yogie argued that a mordan serves to form a chemical bridge between natural dyes and fibers, so that the dye affinity increases against the fibers [5]. Furthermore, according to Suprapto, it is liquids to bind colors that can be used such as alum, lime, salt apple, palm sugar, sugar Java, tamarind, lime, coconut water, vinegar, etc [6].

The process of mordanting is done as follows:

1) Cut the textile material as sample to be stained with size 29x24 cm as many as 6 sheets.
2) Soak the textile material to be stained in a solution of 2 g / liter neutral bar soap means that every 1 liter of water used is added 2 grams of neutral soap. Immersion is done for 2 hours or can be soaked overnight. After that the material is washed and aerated.
3) Cook the silk cloth first into boiling water solution up to 15 minutes by comparison if the weight of the 100 gram cloth of water will be boiled for 2 liters with a temperature of 100 ° C to other substances on the silk fabric. Then, prepare a solution of 1 liter of coconut water to soak the silk cloth for 2 hours, after soaked in the solution, the cloth is removed and rinsed (do not squeeze it) and then dried and ironed. The silk fabric that is ready dipped with natural dye solution from Rambutan skin after being tied up.

4. Design Procedure

Design procedure can be distinguished into three processes. Firstly, it is a process to make the design of the product. Secondly, the implementation of the design into the textile material which is in this case the making of square motif on silk fabric that has been mordanting. The last process is the coloring process by using rambutan skin dye thoroughly or bit by bit in the desired place.
The last process was conducted as follows:

1) Prepare the required tools and materials for the immersion process (the silk fabric has been mordanting with coconut water).
2) Insert the silk cloth into the rambutan skin dyed dyestuff to create a motif, thoroughly insert and soak for ± 30 minutes. Then drain until the water does not drip.
3) After the coloring process is complete, put the fabric into the fixation solution of tawas stone. To make the tie color is more durable, soak it for ± 1hours when the state is still bound. Then release the bond on the silk fabric after the fixation process is complete.
4) Wash the cloth after the coloring process is complete.
5) Dried the silk cloth under the sun. After dry, then iron it neatly and observe the resulting color.

5. Product Trial

5.1. Trial I

Test I conducted by using a rambutan skin dye. It was conducted by mixing between hot and cold coloring ratio of 50:50 cold dye and hot dye. The first silk fabric which has been branched and bonded is inserted into the hot dye solution for ± 30 minutes, then lifted and reinserted into a cold dye solution which has been kept for 24 hours for more viscous color, for ± 30 minutes. The dye used is 2500 ml of rambutan leather dye extracted from 5000 ml of water used to extract rambutan skin to shrink to 2500 ml of dye produced from the extraction process, for dye fabric, tawas stone 500 g for fixation solution which has been prepared before. Silk fabric used has a white base color that has been passed through the process of mordanting by using old coconut water that has been kept for 24 hours, then used as a mordan solution with the process of immersion of silk fabric for 2 hours. The experiments carried out in this engineering study used a square motif.

Figure 2: Test Results I

5.2. Trial II

Trial II was performed with cold stain using rambutan skin dye that has been extracted with a dose of 2500 ml of cold dye and has been kept for 24 hours. Then, the solution was used in this dyeing process for ± 30 minutes of immersion, alum 500 gr for fixation solution which has been prepared before.

Silk fabric used has a white base color that has been through the process of mordanting by using old coconut water that has been kept for 24 hours, then used as mordan solution with the process of soaking the silk fabric for 2 hours. The experiments carried out in this study used a square motif.

Figure 3: Test Results II

5.3. Trial III

The third test was performed with a hot dye. In the process of heat staining the researchers applied a square motif. The coloring process is done by waiting for the dyestuff from the rambutan skin extraction process. The dye extraction process is directly used on the water condition of the dye extraction result while it is still in the heat and soaked immersion ± 30 minutes until the water of natural coloring agent to be cold. The process used hair dyestuff that has been in the extract with a dose of 2500 ml of dye, alum 1000 ml which have been prepared beforehand.

Heat staining means that we cannot use many color variations in a single dye on the fabric. However, this coloring technique is more suitable for the coloring process on the silk fabric because it can absorb the dyestuff properly. So, in the process of rinsing, the resulting color appeared as expected. Therefore, researchers chose to use the process of hot dye.

Figure 4: Test Results III

6. Data Analysis

Data collection required in the management, testing and analyzing of data related to the studied variables, it will be obtained by using research instruments as follows:

1) Questionnaire
Questionnaires used in this study is a tool used to know the data from respondents about the quality of the resulting colors. The technique of data collecting is done by giving a set of written statement to the respondent to be answered. The number of respondents were 30 respondents consisting of 7 Lecturers (expert panelists), 18 students of fashion department (trained panelists), and 5 people (consumers).

2) Observation
Observation is a way of collecting data by holding a direct observation of an object in a certain period and hold a systematic record of certain things observed

3) Documentation
Documentation is a technique of collecting data by means or by documented records (authentic), in the form of statistical data, literature, drawings, leaflets, or brochures contained or encountered in the relevant research sites and support the implementation of research. Documentation techniques used in this study to obtain data on the binding process and the use of dyes.

Data processing in this research is done by statistical analysis, for data processing of research result which includes descriptive statistic analysis To determine the value of color resilience in the fabric based on questionnaire then the data has been collected by using the statistic descriptive to present the results of the assessment aspects using the following formula:

$$P = \frac{f}{N} \times 100\ \%$$

Information:
P = percentage F = frequency N = Number of Sample

Furthermore, the success indicator of this descriptive analysis research is considered effective if all panelists get value on the good category in the aspect of assessment. To measure the success rate of the research then used categorization techniques on aspects assessed in this research.

7. Results and Discussion

The process of rambutan skin extraction is done by boiling dry rambutan skin with a dose of 500 grams of rambutan skin into 5000 ml of water until it shrinks to 2500 ml, for 1 hour. Once extracted then the natural dye of rambutan leather can be used as a textile dye. This dyestuff may be stored and allowed to be reused as a textile dye.

The process of dyeing the silk fabric into the natural dye solution of rambutan skin has been conducted for ± 30 minutes to produce the expected color. After the coloring process, the material should be dried. The process of drying after staining aims to reduce water droplets of natural dyes, so that the dye permeates first into the fiber of silk fabric, before the process of color locking (fixer).

The process of fixation on this cloth is done to maintain the dye on the fabric so as not to easily fade. In this process, the fixation used is alum, while the amount of dosage used is 500 gr / 1000 ml water. The process of releasing the rope bond after the fixation process to see the resulting motifs as expected. After that lift and dry the silk cloth under the sun. In the process of drying should be done under direct sunlight to make the resulting color distributed evenly. Washing process must be done as much as three times. Result of coloring process after washing can be seen in the figure below:

Figure 5: Result of coloring process after washing

In the process of coloring on silk fabric, the testing progress undergoes several different treatments. After seeing the results, the researcher will then conclude to best process that meet the research design criteria especially in term of color change after the washing process, as well as the shrinkage tolerance. The treatment and dyeing process have done as follows:

1. Recent Test Results by Using Heat Staining Process
The third trial process was carried out with a hot dye. In the process of heat staining, the researchers applied a square motif. The coloring process is done by waiting for the dyestuff from the rambutan skin extraction process. After that, the direct dye extraction process is used when the water condition of the dyestuff extraction is still hot and soaked for ± 30 minutes until the water of natural dye becomes cold. The used rambutan skin dyes has been extracted with a dose of 2500 ml of dye, alum 1000 ml for a prepared fixation solution first.

In heat staining process, we cannot use many color variations in a single dye on the fabric, but this coloring technique is more suitable for the coloring process on the silk fabric because it can absorb the dyestuff properly. So in the process of rinsing, the resulting color is still in accordance with the expected. Therefore, researchers chose to use the process of hot dye.

Figure 6: Final Test

2. Final Product Review
The panelist test was conducted by giving the instrument in the form of a questionnaire to a number of panelists of 30 respondents. The panelist tested results with coconut water as

mordan and rambutan skin as natural dye, the result was presented in the form of a sheet of silk fabric that has been colored with tie dye technique to produce square motif. After the process of coloring and washing process which has been conducted as much as 3x washing. The color of the fabric has changed when the cloth was washed repeatedly resulting in darker color. It indicated that coconut water has succeeded to facilitate and enlarge the amount of dyestuff that seeps into the fabric fibers. Both on the size of the colored fabrics change in size from 29x24 cm to 20x25 cm which has undergone the process of shrinkage and repair of the final product, as shown in the picture below:

Figure 7: Coloring Results

The dyeing process started from collecting fresh rambutan skin and then dried for one week until the rambutan skin is completely dry. Before conducting the dyeing process, the researcher prepared the tools and material which will be used in the experiment. Once the tools and materials ready, the process were started. Rambutan skin had been put into the pot containing 5000 ml of water and then boiled for ± 2 hours until the water rambutan skin shrined to 2500 ml. The dye resulting from this process then kept for 24 hours to produce more viscous dye. If the dye wanted to be used, it should be reheated first.

After the process of extracting finished, the silk fabric that has been cut to the desired size of 24x29 cm dimordanting with old coconut water that aims to simplify and enlarge the amount of dyes into the fabric fibers and can reduce the color of the fabric after washing process, and increase the brightness of the color that goes into the fabric fibers.

This is in accordance with the results of Akbar Raditya research about changes in the physical and chemical properties of silk fabrics due to the natural dye skin root mengkudu [7]. It showed that the use of mordan can reduce the color of the fabric to the effect of washing. This indicated that mordan compounds were able to bind colors so that they did not fade easily and increased the amount of dyestuff absorbed by the fabric fibers. It can also increase the color brightness of the fabric.

Dyeing process will not be perfect if cloth has not been put into the dye. After the fabric passed the mordanting process then the dyeing process with tie dye technique will be conducted to make a motif on the fabric. It was done by tying the fabric with a rope in accordance with the desired shape. It is in line with Hasyim and Zulaikah research [4][8].

The next process is to do the fixation or locking of the dye prior to the washing process which aims to bind the dyestuff so as not to fade easily to the effect of washing. The fixation process usually uses natural ingredients or chemicals such as alum which aims to wash the color after dyed with natural dye in order to have good fastness. This opinion is in accordance with that proposed by Prasetyo [9]. After performing all of the dyeing process, the dyed silk fabric can be tested for its fastness and brightness of the color by washing process for 3x leaching and then the researchers observed the results of all process.

The results showed that the silk fabric that has been treated by dyeing process with tie dye technique and utilizing coconut water as mordan with natural dye of rambutan skin resulting color is brown. In this research, if the cloth is washed several times, the resulting colour will be darker. Thus, it can be said that coconut water can be an alternative solution of natural mordan because it contains electrolytes, chloride, calcium, potassium, magnesium, sodium, and riboflavin [5]. It can increase the amount of dyes that enter into the fabric fibers and increase color brightness on the fabric. This opinion is in accordance with the proposed by Muhtadin that the addition of electrolyte into the dye solution aims to increase the amount of dyestuff absorbed by the fabric even though the various dyestuffs will have different adhesions [10].

In this process of coloring, researcher get result of color of brown which will appear in darken color when washed repeatedly. Researcher also get result that use coconut water as an excellent mordan solution to simplify, enlarge and increase the brightness of dyestuff absorbed by environmentally friendly, safe and well-worn fabrics used for long periods of time and does not endanger health when compared to the use of harmful chemicals for skin and health. Rambutan skin as a natural dye that is durable and able to produce a good color in accordance with the expectations of researchers even during the process of making the dye takes a very long time but this natural dye is better when compared with synthetic dyes that circulate in the textile industry in recent time.

The panelist opinion of the staining on the silk cloth using rambutan skin coloring agent and coconut water as mordan after testing the result fabric are explained as follows:

a) Lecturer of Home Industrial Education department
The lecturer panelists argue that the colors produced on silk materials generally appear in very good presentation, and the sheen of the fabric remains the same but after the washing process the fabric is darker than before the washing process. The resulting motif is in accordance with the planning expected by the researcher. If applied to a wider cloth it will be very good and interesting.

b) Students of the Family Welfare Approach
Based on the results of panelist opinion test from PKK students of fashion in general they said the color produced on silk cloth is very good, but for the motives produced respondents say good as flat motif cannot be assessed in this coloring process because using tie dye technique.

c) The general public
Panelist test results from the general public (consumers) said the results of color and motives produced respondents said overall very good and interesting if used as a ready-made clothing. And safe for health if used for long periods of time, and environmentally friendly.

Overall, the results showed that coconut water can be used as a natural and environmental friendly mordan. There were about 90.83 % of panelist gave very good rate to the color of silk fabric in term of its cloth sheen, sharpness, flatness and cloth shrinkage tolerance. Therefore, the coconut water can be used as an alternative mordal solution and natural dye for textiles.

8. Conclusions and Recommendations

Dyeing process done in this research can be divided into several stages which are: preparing tools and materials to extract the dyestuff from rambutan skin, doing the mordanting process, dyeing process with tie dye technique, preparing and doing the fixation process to lock the dyestuff to not fade during the washing process.

The resulting color is a light brown color. From the results of this study the longer the cloth washed the darker the resulting color.

The panelist opinion on the utilization of coconut water as mordan on natural dye of rambutan leather for silk fabrics with tie dye in general technique gave very good rate. Therefore, it can be said that, the utilization of coconut water as a natural mordan is environmentally friendly, and safe for health. It aims to simplify, increase the brightness of color and increase the amount of dyestuff absorbed by the fabric, with 90.83% percentage say very good, and only 65.83% say enough or less.

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