The use of laban (Vitex pinnata L) leaf as a silk pigment

W Prasetyaningtyas¹, S Wati¹ and R Buang²

¹Department of Home Economic, Faculty of Engineering, Universitas Negeri Semarang, Kampus UNNES Sekaran Gunungpati 50229 Semarang Indonesia

²Kolej Kemahiran Tinggi Mara Rembau, Negeri Sembilan Malaysia

wulan_sari@mail.unnes.ac.id

Abstract. Synthetic dyes are usually carcinogenic, therefore it is necessary to use alternative dyes to reduce the use of synthetic dyes, namely by using natural dyes. This study aims at determining the potential of Laban leaves as a natural dye in silk fabrics. Extraction was done by boiling the leaves for 1 hour. The dyeing of the mordanted cloth was done 4 times. The dyed fabrics were treated with post mordanting using alum, calcium oxide and tunjung with a concentration of 50gr / l. Fabric testing was carried out by testing the color strength and color fastness to washing with soap. The results of the color strength test showed that the highest value was obtained by the use of tunjung with a T% value of 88.96 for very dark criteria, then followed by calcium oxide mordant with a value of 30.20 and the lowest value on the use of alum mordant with a value of 20.97 for light criteria. The color fastness test to washing generated an average value of 4 which was in the good category.

1. Introduction

Synthetic dyes began to shift the application of natural dyes, because the colors produced by synthetic dyes were more diverse. The advantages of synthetic dyes compared to natural dyes including fixed color composition, more color variants, ease of use, brighter coloring results, availability for all types of fibers and generally better fastness and easier to use. Natural dyes are starting to be abandoned due to several obstacles, including the difficulty of finding raw materials, the complexity of the manufacturing process and their low fastness. This condition makes batik craftsmen switch to using synthetic dye.

The negative impact of using synthetic materials containing azo and used directly as dyes, especially in clothing, will trigger skin cancer (90% damage epidermal cells) because of its carcinogenic properties [1]. This condition resulted in the warning about the danger of synthetic dyes containing azo. As a result of this regulation, the trade route for synthetic dyes containing azo with all its products, especially those directly affected human skin, has been banned.

In Indonesia, there are abundant natural dyes that can be used as a source of natural dyes. Natural dyes are developed by exploring the abundant sources of natural dyes. This exploration was intended to determine the color produced. It is hoped that it can enrich the types of natural dye from plants so that their availability is always maintained and the resulting color variations are increasingly diverse. Natural dyes for fabrics / textiles are generally obtained from the extraction of various plant parts such as roots, stems or wood, leaves, seeds or flowers [2]. Some natural dye plants that can be used including: tingi wood (Ceriop tagal), jambal wood (Poltophorum pterocarpum), secang wood
(Caesalpinia sappan), jalawe fruit (Terminalia bellirica), Indigofera tinctorium plant, and Brachiaria mutica. Vitex pinata L has the local name "Laban" in Indonesia, "Gulimpapa" in Sulawesi, "Leban" in the Dayak Tribe of East Kalimantan, "Kopih" in Sumatra ",, "Heketaroe "in Sumba Island and" Pampa "in Komodo Island. Laban is a plant that grows well in secondary forests, along rivers and along roads including marginal roads. The Laban tree grows well in tropical conditions such as in Indonesia, flowering and fruiting most of the time from January to December, and spreading by seed. Laban wood is locally used for building materials for houses, boats, furniture, bridges, making knife handles and also firewood while the leaves are used for animal feed, but so far only the wood has been used and the leaves have not been utilized optimally. Seeing this condition, there is no use of Laban leaves as natural dyes for textiles. Natural dyes can appear optimally when applied to textiles made of natural fibers. While the natural fibers that can receive the maximum color are silk fibers. Based on the above background, there has been no follow-up use as a natural dye in silk batik cloth. It is therefore they analysis of laban leaves (Vitex pinnata L) as silk batik fabric dye was carried out. The objectives to be achieved from this study were to examine whether the leaf extract can be used as a dye for silk batik cloth and to analyze the quality of the coloring results in the aspects of color direction, color strength and color fastness of silk batik cloth.

2. Theory
The morphology of this Laban tree (Vitex Pinnata L) grows upright and has branches, tree height is up to 2-25 meters, diameter up to 40 cm, bark is cracked, peeled, yellowish gray to pale brown, pale green skin turns yellow on the inside of the exposure, soft yellow to brown, leaves consisting of 3 - 5 foliolate, two leaves smaller than others, oval or elliptical leaf shape, 3-25 cm long, 1.5-10 cm wide, whitish blue flowers, fruit or seeds 5-8 mm thick, black ripening. The habitat of Laban trees grows well in secondary forest, on the banks of rivers and along roads including marginal roads. It grows well in tropical conditions, flowering and fruiting almost intermittently from January to December, propagating by seed. Laban wood has very strong and durable wood even in contact with water or soil. The density is approximately 930 kg per cubic meter (58 lb per cubic foot).

Natural dyes could be obtained from plants, animals and minerals. In these materials there are pigments that produce color. Some of the many natural pigments found in plants include: chlorophyll, carotenoids, tannins and anthocyanium. Likewise with Laban leaves, these natural pigments are found in Laban leaves. Chlorophyll (chlorophil) is a green color carrier substance in plants. Carotenoids are one of the natural pigments in the form of yellow to red dyes. Usually bound with chlorophyll in chloroplasts from green leaves of plants. Some carotenoids consist only of hydrogen and carbohydrates, this sub group is called carotene. Other sub-groups are oxygenated carotenes (xanthophylls), carotenoid acids and esters (xanthophyll esters) [5]. Tannins are brown color-giving pigments that can be obtained from plants. Tannins are complex compounds, usually a mixture of polyphenols that do not crystallize. Anthocyanin (anthocyanin) is a water soluble pigment that occurs naturally in various types of plants [6]. As the name implies, this pigment provides color to flowers, fruit and leaves of green plants, and has been widely used as a natural dye in various food products and in various other applications. Figure 1 shows picture of laban leaves.
Anthocyanin provides color due to their long arrangement of conjugated double bonds, so they can absorb light in the visible range of light [7]. Laban (Vitex pinnata L) The wood is not so important commercially because it is not usually available in large quantities. However, it is usually used locally for building materials for houses, boats, furniture, bridges, making knife handles and also firewood, while the leaves are used for animal feed. So far, only the wood has been used, while the leaves have not been fully utilized. Natural dyes are dyes obtained from nature / plants. Each plant contains a colorant that is determined by the intensity of the color produced by the pigment, which is highly dependent on the coloring matter (organic compound) which determines the direction of natural color in each plant, sometimes containing more than one color type. Parts of plants that can be used for natural coloring are leaves, flowers, stems / bark, roots and skins and seeds / fruits. In general, natural dyes are formed from a combination of three elements, namely: carbon, hydrogen and oxygen. There are several natural dyes contain other elements, such as nitrogen in indigo and magnesium in chlorophyll. Pigments are also present in animal cells. Biochemists have identified thousands of pigments that are from plants and the mechanisms and functions of these pigments [5]. Silk is the oldest type of fiber in the world after linen and cotton. Silk fibers are filamentous fibers obtained from a type of insect called Lepidoptera; silkworm larvae when forming a cocoon, which is a caterpillar shape before becoming a butterfly, produce these fibers. The main species of silkworms is Bombyx mori.

Mordant is a metal salt, such as aluminum, iron, tin, or chromium which functions to form a chemical bridge between natural dyes and fibers so that the affinity of natural dyes increases to fiber [8]. Natural dyes are included in the mordant dye class, or in Javanese it is called “sarenan”, its function is to generate colors in the direction of the color according to the type of composition and strengthen the color. The substances used for sarenan include lime / limestone, alum, and gazebo. Mordant is a substance that is used to increase the attractiveness of natural dyes to textiles and is useful for producing good evenness and color sharpness. The above understanding can be concluded that, mordants are metal salts that function to generate color on textiles and are useful for producing good color sharpness. There are 3 types of mordant commonly used for batik, including the following:

2.1 Alum
Alum is a double salt of aluminum sulfate sulfate, which is used to purify water or a mixture of Al2 (SO4) 3 dyes. Alum is a dark white crystal, translucent, slightly sour in taste when licked, enhances color but can also be used as a water purifier.

2.2 Calcium Oxide
Calcium oxide (CaO), commonly known as lime or raw lime, is a chemical compound that is widely used. Quicklime is alkaline crystals, in the form of white to pale yellow / brown powder, odorless.
2.3 Tunjung
Tunjung (iron salt) is a chemical compound with the formula FeSO$_4$. In ancient time, it was known as coppersas & vitrol which is green in color, heptahydrate which is blue - green in color.

The color excess in the dyeing process can be shown from the dark and light values of the dyeing results. The value of color strength can be seen through the R% (reflectance) test using a UV-VIS PC 2401 spectrophotometer which is then converted into a T% (Transmittance) value, the color aging value determines the level of color difference or contrast from the lowest level to the highest level.

Color fastness is a change in color due to some reason so that the color gradation changes or fades, color fastness leads to the ability of the color to remain stable and does not change color fastness including sun fastness, washing, iron rubbing, sweat and others. The color fastness value can be seen from the change in the original color of the stain test and assessment of the white cloth. Assessment of fabric color fastness can be seen from 2 scales, namely the standard gray scale (gray scale) and the staining scale.

3. Research Methodology

3.1 A Tools and Materials
The tools used in the experiment, namely scale, measuring cup, stainless steel pan, stirrer, stove, frying pan, canting cap, basin, scissors, hanger, clamp.

The materials used in the experiment were laban leaves, silk cloth, filter gauze, water, wax, alum, calium oxide, straight.

3.2 Laban Leaf Extraction
Extraction is a term used for every activity, where the components of the material move into other liquids or solvents. The process of making a natural dye solution is the process of extracting the color-inducing pigments in plants, whether found in leaves, stems, fruits, seeds, or roots. The exploratory process of taking natural dye pigments is called the extraction process. This extraction process is carried out by boiling the ingredients with water solvent. The part of the plant that is extracted is the part that is indicated as the strongest or has a lot of color pigment, for example the leaves, stems, roots, fruit skin, seeds or fruit.

Laban leaf extraction process is a process of taking dye from Laban leaves which will be used to dye textile materials, in the following manner:
a. Fresh Laban leaves are washed and then cut into pieces and weighed according to the recipe, then boiled with water according to the recipe for + 1 hour to obtain ½ - 1/3 of boiled water (color extract) as much as the recipe.
b. Boiled laban leaf extract (color extract) is then filtered to obtain a clean color extract (does not contain dirt and leaves of Laban)
c. And the filtered extract of the Laban leaf color after cold is ready to be used for dyeing textile materials such as silk.

The extraction composition is as follow:

- Laban leaves (Vitex Pinnata L): 2.5 kg
- Water (for boiling): 5 liters
- Boiling temperature: 100oC
- Extract color: 1.5 liters
• Vlot: 1: 10

3.3 Dyeing Silk Cloth with Laban Leaf Extract

The process of dyeing silk cloth, the dyeing process is a process of giving color to the fabric / textile material evenly with the dye. The dyeing process used is cold dyeing. This method is used to dye the wax batik cloth, in the following procedure:
1. The silk cloth that has been through the mordanting process and is ready to be dyed is then put into the cold laban leaf extract solution for 60 minutes, turning it every time.
2. After 60 minutes, the silk cloth is removed and dried by hanging it (on it) or aerating it.
3. After drying, the silk cloth was immersed again in the solution of the extract of the leaf color and was repeated 4 times.

4. Result and Discussion

4.1 Color Strength

Data collection of color strength was carried out by looking at the value of the color strength test (Transmittance = T%) with the ISR-2200 model Spectrophotometer (UV-PC). The value of color strength determines the level of color difference or contrast from the lowest to the highest level [9]. The color strength data that has been obtained will then be analyzed descriptively.

| Table 1. Color Strength Criteria (T%) |
|---------------------------------------|
| Color Strength Value (T%) | Criteria |
|---------------------------|----------|
| 0 - 20                    | Very light |
| 21 – 40                   | Light    |
| 41 – 60                   | Dark enough |
| 61 – 80                   | Dark    |
| 81 - 100                  | Very dark |

The color saturation is used to determine the ratio between the amount of solution and the weight of the textile material being processed. Darker colors can be produced using a small dip ratio in the hope that only a small amount of the dye is wasted or lost. Study on color strength has been done, the results is given in Table 2.

| Table 2. Color Strength |
|-------------------------|
| Sample                  | Test number | Color Strength Testing Score (R%) | Mean (R%) | Mean T (%) | Criteria |
| White fabric            | 1           | 105.03 | 105.03 | -5.03 | Very Light |
| Alum                    | 2           | 79.85 |
| Calcium Oxide           | 2           | 78.6  | 79.03 | 20.97 | Light |
| Calcium Oxide           | 3           | 78.65 |
| Calcium Oxide           | 1           | 70.14 |
| Tunjung                 | 2           | 69.74 | 69.98 | 30.2 | Light |
| Tunjung                 | 3           | 70.06 |
| Tunjung                 | 1           | 12.03 |
| Tunjung                 | 2           | 10.26 | 11.04 | 88.96 | Very Dark |
| Tunjung                 | 3           | 10.83 |
The results showed that there was a significant difference in color strength in the use of alum mordant, calcium oxide and tunjung on the results of dyeing silk with laban leaf color extract. The strength level of silk cloth using tunjung mordant produce a darker color than alum and calcium oxide. This is because the tunjung mordant contains iron, which causes a darker color. Calcium oxide mordant contains calcium, causing a slightly darker color. Mordant alum contains copper (COS4) causing a light color. From the results of the color strength test (T%) the highest value was found in mordant tunjung with a T% value of 88.96 (very dark), then followed by calcium oxide mordant with a value of 30.20 (light) and the lowest value was mordant alum with a value of 21.97 (light). The results showed that there was a significant difference in the use of different mordant with the same mordant concentration, namely 50gr / l in the aspect of color strength of silk batik color by dyeing it 4 times.

4.2 Color Fastness to Washing

Assessment by measuring fastness was done by assessing the original color change. This measurement or assessment was carried out by comparing the color change that occurs with the standard of color change. The color fastness assessment was measured using the Standard Gray Scale for color changes and the Standard Staining Scale for color staining.

In the gray standard, an assessment of color fastness and suitability was carried out by comparing the differences in the tested sample with the original color samples against the corresponding differences of the color change standard array depicted from lowest to highest grade.

Table 3. Table of Color Difference (Grey Scale)

| Color Fastness Score | Color differences (in CD) | Tolerances for Work Standards (in CD) | Criteria |
|-----------------------|---------------------------|--------------------------------------|----------|
| 5                     | 0                         | 0.0                                  | Very good|
| 4-5                   | 0.8                       | ±0.2                                 | Good     |
| 4                     | 1.5                       | ±0.2                                 | Good     |
| 3-4                   | 2.1                       | ±0.2                                 | Good enough|
| 3                     | 3.0                       | ±0.2                                 | Enough   |
| 2-3                   | 4.2                       | ±0.3                                 | Less     |
| 2                     | 6.0                       | ±0.5                                 | Less     |
| 2-1                   | 8.5                       | ±0.7                                 | Poor     |
| 1                     | 12.0                      | ±1.7                                 | Poor     |

On the Staining Scale, the stain assessment of white cloth in the color fastness test was carried out by comparing the color difference of the stained white cloth to the differences described by the Staining Scale.

Table 4. Table of Staining Scale Assessment Standards

| Color Fastness Score | Color differences (in CD) | Tolerances for Work Standards (in CD) | Criteria |
|-----------------------|---------------------------|--------------------------------------|----------|
| 5                     | 0                         | 0                                   | Very good|
| 4-5                   | 2.8                       | ±0.3                                 | Good     |
| 4                     | 4.5                       | ±0.3                                 | Good     |
| 3-4                   | 5.6                       | ±0.4                                 | Good enough|
| 3                     | 8.0                       | ±0.5                                 | Enough   |
| 2-3                   | 11.2                      | ±0.7                                 | Less     |
| 2                     | 16.0                      | ±1.0                                 | Less     |
| 2-1                   | 22.5                      | ±1.0                                 | Poor     |
| 1                     | 32.0                      | ±2.0                                 | Poor     |
The color fastness test was carried out by observing the change in the original color of the test sample, using the gray scale standard to assess the color tarnish on white cloth, based on data from the table of the color fastness test values against washing of mordant alum, quicklime, and alum did not have a significant difference, namely obtained an average value of 4 in the good category. This shows that the extraction of Laban leaves, which is applied to silk batik cloth is quite good.

Based on the results of research and laboratory tests, there was no significant difference in the quality of color fastness to the washing of silk cloth that was dyed with mordant alum, calcium oxide and tunjung. It shows the potential of laban leaf as natural dyes of batik process. Batik is the process of writing a picture or decoration on any media by using wax batik as a color barrier [10].

In general, the value of discoloration or color fastness to washing is good. This is due to the large concentration of the mordant alum, calcium oxide and arbor solution, which is 50gr / l. Judging from the color fastness resistance to washing silk cloth from laban leaf extract with mordant alum, calcium oxide, and tunjung, through laboratory tests did not get any significant results. This shows that the quality of silk batik cloth with leaf color extract of laban with mordant alum, calcium oxide, and tunjung has the same quality (good) even though each sample was tested 3 times. Referring to the results of this study, it can be concluded that the color extract of laban leaves can be used as a natural dye in dyeing silk batik cloth using mordant alum, calcium oxide and tunjung at a concentration of 50g / l to obtain good fastness quality to washing. Color fastness to wash is one of the important tests for silk material [11].

Figure 2. The result of staining silk with alum mordant

Figure 3. The result of staining silk with calcium oxide mordant

Figure 4. The result of staining silk with tunjung mordant
5. Conclusion
The results of the color strength test have the highest value on the use of tunjung mordant with a T% value of 88.96 for very dark criteria, then followed by calcium oxide mordant with a value of 30.20 and the lowest value on the use of alum mordant with a value of 20.97 for light criteria. The color fastness test for washing generated an average value of 4 which was in the good category.

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