Research article

APPLICATION OF NATURAL COLOR MIXED AND NaCl AS MORDANT ON WOOD FIBER USING SIMULTANEOUS MORDANTING

Ni Wayan Bogoriani[1*]

[1]*Chemistry Dept., Faculty of Mathematics and Natural Sciences Udayana University*

**Corresponding author: wayan_bogi@yahoo.com*

ABSTRACT

Wood is one of the few materials that is highly exploited by humans, resulting in increasing usage of low quality wood. High demand and usage on high-quality wood causing heavy reduction of its availability. To increase artistic value of low quality wood, staining on the surface of the wood need to be done. This research aims to apply a mix of natural pigments (Gambier- *Piper betle* leaves- *Areca* seeds) and NaCl salt as the mordant on the surface of Albesia wood fiber and test the physical and chemical dye properties with 1% detergent. This study uses a mixture of natural dyes (Gambier- *Piper betle* leaves- Areca nut) with various concentrations and salt as auxiliaries, carried out with the simultaneous method of mordanting. This study was divided into 7 groups. Differences in mean between groups were tested using One Way ANOVA followed by Post Hoc LSD, which revealed statistically significant test when p value < 0.05. The results showed that there were significant differences of natural dyes mixed applications (Gambier- *Piper betle* leaves- Areca seeds) in the ratio of 5.0: 3.0: 3.0 to 0.5 g of salt as auxiliaries and 10 minutes of immersion with the simultaneous method of mordanting. Ratio of the dye mixture, on the surface of the wood causes brown color and has the highest absorption average of 0.19 gram and the durability of the dye showed the highest seen from the appearance of color and mix of the missing mass. It can be concluded that the best application is with a mixture of natural dyes and the addition of 0.5 g of NaCl salt on the surface of Albisia wood fiber with the simultaneous method of mordanting and also based on the durability of the dye test is a ratio of 5.0: 3.0: 3.0

Keywords: Areca seeds, Piper betle leaves, gambier, NaCl, mordant

INTRODUCTION

Bali is one of the famous tourist destinations in the world. Various potential and existing resources become the main attraction for tourists both local and foreign tourists, particularly distinctive art and culture. Many quality art objects that show Balinese culture characteristic can be found on this island. Many of the art objects are made of wooden materials, carvings, sculptures and souvenirs and are popular in the market, both for domestic and international visitors. Wood is one of the few materials that are highly exploited, causing scarcity and resulting in lower quality of wood increase its use. Therefore, it is important to improve and maintain the quality of wooden goods to improve its value (Herawati, 2005).

Today the majority of art objects from wood that are favored in the market are wood that have been surface stained with a dye similar to wood color, so it looks more natural and have aesthetic value. Long economic

crisis has decreased the number of people whose earnings depend on making art objects of wood, because the price of dyes that are sold in the market are quite expensive, while the selling price is lower than the purchase price, so that people do not make a profit. On the other hand, synthetic dyes are widely available at an economical price and produce a wide variety of colors; these dyes however produce skin allergy, toxic wastes and other harmfulness to human body (Alemayehu and Teklemariam, 2014). To anticipate these problems it is necessary to look for alternative, i.e. using a mixture of natural dyes derived from plants, where the materials are easily available, inexpensive, and easy to handle and has a quality that is not inferior to the dye on the market. Natural dyes too are known for their use in coloring of food substrate, leather as well as natural protein fibers like wool, silk and cotton as major areas of application since pre-historic times.

The use of non-allergic, non-toxic and eco-friendly natural dyes on textiles becoming importance due to the increase environmental awareness to avoid hazardous synthetic dyes. Recently, a number of commercial dyers and small textile export houses have started looking at the possibilities of using natural dyes for regular basis dyeing and printing of textiles to overcome environmental pollution caused by the synthetic dyes (Agarwal, 2009; Alemayehu, and Teklemariam, 2014).

Mixture of natural dyes for wood surface is gambier, betle leaves, areca seeds, and water. In everyday life, mixtures of the three ingredients are commonly used for traditional chews. It is believed to strengthen teeth roots. The discarded saliva after chewing has reddish brown in colour. This kind of color can be used to color the wood surface.

Natural dye mixture is consider environmentally friendly and do not have side effects. However, it has disadvantage which is not able to color timber permanently because it has less strong bond, so it is easily fades. Therefore, it is necessary to supplementing (mordant) to strengthen the bonds and sharpens the colors. Mordant is a very important component, and it is added to the mixture of natural pigments to strengthen the bond between the fiber and dye to prevent the color erosion due to light and leaching. Mordant is used to form a chemical bridge between natural dyes with fiber so that affinity of dye to fiber can be increased (Fitrihana, 2008).

According to Bogoriani (2009; 2010 and 2011), a mixture of natural dyes in gambier, betle leaves and areca seed with the addition of mordant successively with $CaCO_3$; $KMnO_4$ and citric acids produce a brown color in acacia wood and albasia. According to Fitrihana (2007), mordant can be acids, bases and salts. Mordant used in this study is NaCl salt. Salt is an anorganic compound found in the kitchen. Albasia wood staining methods in mordanting was done simultaneously, which means a mixture of dyes and NaCl were mixed together with heating to boil for 10 minutes.

MATERIALS AND METHODS

Research materials

The chemicals used in this study are NaCl salt, 1% detergent water and distilled water, powder of areca seed, betle leaf powder, gambier powder and albasia wood.

Equipment

The equipment used in this research are analytical balance, filter paper, knife, blender, strainer, funnel, stir bar, spatula, pipette, glass beaker, a sample, a spray bottle, electric bath, stopwatch.

Extraction of natural dyes

Ratio of areca nuts, betle leaves and gambier.

Mixing ratio of Gambier-betle leaves-areca seeds in 100 ml of water were determine as follows: 3.0 g-3.0 g-3.0 g; 3.0 g- 4.0 g-3.0g; 4.0 g-3.0 g -3.0 g; 4.0 g- 4.0 g -3.0 g; 3.0g-3.0g-5.0 g; 3.0g-5.0 g-3.0g; and 5.0 g-3.0g-3.0g. Each mixture was added with 100 mL distilled water, and then heated in a Beaker glass for about 15 minutes. Once cool, the extract produced were filtered.

The determination of optimum mass from natural dyes mixture

Mix of color extracts that have been prepared was then entered to a four-wood that had been prepared as control treatment with 10 minutes soaking, and then dried and weighed. Then, each dye extract was added with 0.5 g of NaCl, followed by 10 minutes heating, and then cool at room temperature. Four pieces of the wood timber, 4 x 5 x 1 cm in size were labeled A, B, C and D. Those wood pieces were immersed for 10 minutes, dried and then weighed.

Endurance test

For the endurance test, colored wood that has been dried were treated as follows: timber A is not soaked with water detergent 1% (control), timber B and C soaked with water detergent 1% for 15 minutes. Observation was performed on the wood color with parameters (+, ++, +++). Mark + means color fading. More + means stronger color. Mass weighed was measure to determine the amount of reduced mass.

Statistical analysis

Data were analysis statistically using one-way ANOVA and if there are significant values, data were further analysed using least-significant-difference test (LSD) using Alpa 0.05 to determine differences between treatments. Values are also expressed as mean ± SD.

RESULTS AND DISCUSSION

Manufacture of natural dyes from a mixture of Gambier - betle leaf -Areca nut has been done by solvent extraction with water and each prepared in powder form. Ratio of mass of each ingredient made certain dyes to facilitate observation of the colors it produces. The extraction process is done by heating, dye mixture was added with 100 mL water and heated to boil for 15 minutes and then filtered with gauze. Extracted dye was placed in a container and ready for coloring 4 x 5 x 1 cm albasia wood by soaking it for 10 minutes either without the addition or with kitchen salt.

Result showed that the mixture of natural dyes able to color albasia woods surface. Natural dyes are extensively used in various fields of everyday life such as food production, textile industries, paper production, and agricultural practices (Cserhati, 2006). Nowadays customers demand natural products as a consequence of proven toxicological effects of some synthetic compounds (Sowbhagya and Chitra, 2010; Yusef *et al*., 2014).

Albasia wood staining with Extract Dyes without the addition of kitchen salt

Wood staining in all dye mixture ratios without the addition of salt give light brown color and become discolored when tested with 1% detergent solution. It caused by a mixture of natural extracted dyes which is classified as reactive dyes, which means that absorption of the fiber is not good. Dye does not react with the fibers and is easily removed. Liaison dye groups can affect the absorption and durability of the dye to acid or base. Reactive groups are parts of the dye easily separated. With the release of these reactive groups, dye becomes readily react with the wood fiber / OH group of cellulose and lignin, which is a chemical component of wood fiber. In order to mix the dye can react with the fiber then added auxiliaries. Mordants and dyes will have different effects depending on the fibers used (cellulosic or protein) 16. The seed extracts were applied to cotton fiber, cotton cloth, silk fiber and chart paper to evaluate their efficiency as a coloring material (Meena-Devi, Ariharan and Nagendra-Prasad, 2013).

Determination of Ratio Optimum mass Mixed Gambier- Betle leaves- areca seed By addition of NaCl salt.

Albasia wood measuring 4 x 5 x 1 cm was surface flatten and smoothen with sand paper and weighed the mass (Table 1 and Figure 1) prior to the coloring process. The aim is to determine the absorption of dye by albasia wood so that after the coloring process, the wood is weighed again. Dye extraction mixture was added with 0.5 g kitchen salt (NaCl) and heated for 10 minutes. Then, at room temperature, wood soaked in the dye mixture for 15 minutes for all dye mixture ratios. Based on observations, appearance of brown colors on the wood surface varies depending on the ratio (Table 1). The purpose of salt addition is to release the reactive groups of the dye to become non reactive, so it is easily reacted with the fibers to form a covalent bond primer which is binding pseudo ester or ether, and with the use of aqueous solvent can also conduct the hydrolysis reaction with a molecule reactive dye into non reactive. This hydrolysis reaction will grow very fast with the rise in temperature (Bogoriani and Putra, 2009; Bogoriani, 2010; and Bogoriani, 2011).

Data in Table 1 and Figure 1 shows that there are significant differences on time of mixture ratio of natural pigments found in ratios 5.0: 3.0: 3.0 (Gambier: betle leaves: areca seed) at p value < 0.05 compared to the other group. Such ratios provide absorption of the dye highest and durability test very low (5.0: 3.0: 3.0 g) compared to others with the same immersion time and the amount of NaCl is added the same.

Durability Test of Dye with 1% Detergents Water

Data in Table 1 show that the resistance of dyes to washing of 1% detergent solution by immersion in 15 minutes did not change significantly (+++),which shown from the appearance of color after the test, and compared with a control. This applies to all future ratios dye mixture.

Table 1. Result of Ratio Determination Mass of Mixed Natural Dyes with 0.5 grams of NaCl salt and 10 minutes soaking as well as endurance test dye with 1% detergent water

Ratio dye mixsed (Gambier-betel leaves-Areca seed) (g)	Absorption average of dye mixsed + 0,5 g NaCl (g)	*P*	Dye wood surface	Mass of average lost after endurance test dye with 1% detergent water (g)	*p*	Dye wood surface
3:3:3	0,178±0,015[b]	0.001 0,471 0,101 0,101 0,809 0,234	Light brown	0,025±0,013[g]	0.412 0,412 0,412 0,412 0,412 0,020	Light brown
3:4:3	0,140±0,08[a,c,f,g]	0.001 0,008 0,063 0.063 0.003 0.000	Light brown	0,020±0,008	0.412 1,000 0,109 1,000 1,000 0,109	Light brown
4:3:3	0,170±0,014[b]	0.471 0,008 0,338 0,338 0,629 0,063	Light brown	0,020±0,008	0.412 1,000 0,109 1,000 1,000 0,109	Light brown
4:4:3	0,160±0,025[g]	0.101 0,063 0,338 1,000 0,156 0,008	Light brown	0,030±0,008[g]	0.412 0,109 0,109 0,109 0,109 0,003	Light brown
3:3:5	0,160±0,08[g]	0,101 0,063 0,338 1,000 0,156 0,008	brown	0,020±0,008	0.412 1,000 1,000 0,109 1,000 0,109	brown
3:5:3	0,175±0,013[b]	0.809 0,003 0,629 0,156 0,156 0,156	Light brown	0,020±0,041	0.412 1,000 1,000 0,109 1,000 0,109	Light brown
5:3:3	0,190±0,08[bde]	.0,234 0,000 0,063 0,008 0,008 0,156	brown	0,010±0,000 [a,d]	0.020 0,109 0,109 0,003 0,109 0,109	brown

[a] indicates significant differences from mixsed dye Gambier-betel leaves-Areca seed (3:3:3)
[b] indicates significant differences from mixsed dye Gambier-betel leaves-Areca seed (3:4:3)
[c] indicates significant differences from mixsed dye Gambier-betel leaves-Areca seed (4:3:3)
[d] indicates significant differences from mixsed dye Gambier-betel leaves-Areca seed (4:4:3)
[e] indicates significant differences from mixsed dye Gambier-betel leaves-Areca seed (3:3:5)
[f] indicates significant differences from mixsed dye Gambier-betel leaves-Areca seed (3:5:3)
[g] indicates significant differences from mixsed dye Gambier-betel leaves-Areca seed (5:5:3)

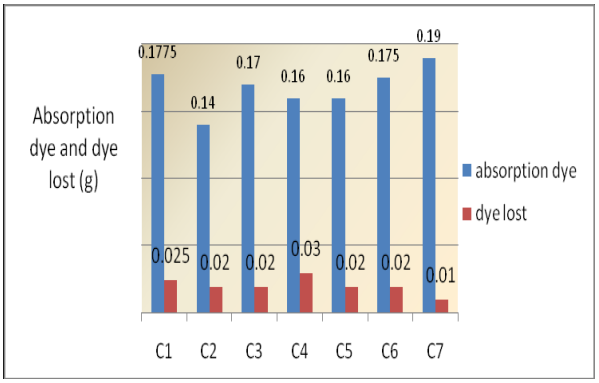

Fig.1. Mean dye absorption dye mass and the average of dye lost

C1 : Ratio of Gambier- betel leaves- areca seeds (3-3-3)
C2: Ratio of Gambier- betel leaves- areca seeds (3-4-3)
C3: Ratio of Gambier- betel leaves- areca seeds (4-3-3)
C4: Ratio of Gambier- betel leaves- areca seeds (4-4-3)
C5: Ratio of Gambier- betel leaves- areca seeds (3-3-5)
C6: Ratio of Gambier- betel leaves- areca seeds (3-5-3)
C7: Ratio of Gambier- betel leaves- areca seeds (5-3-3)

Usage of natural dyes obtained from dye mixture in albasia wood finishing has good light fastness. This will also help in keeping the skin healthy by preventing from allergy and reduce the risk of skin cancer. The light fastness and wash fastness under standard condition (50°C) and also at 20°C with a washing formulation used in conservation work for restoration old textiles. Some dyes undergo marked changes in color on washing due to the presence of even small amounts of alkali in washing mixtures, high lighting the necessity to know the pH of alkaline solutions used for the cleaning of textiles dyed with natural dyes. As a general rule, natural dyes show moderate wash fastness on wool (Mishra and Patni, 2011).

The natural dye obtained is biodegradable and nontoxic. The natural dye obtained from dye mixture also has medicinal properties and finds its application traditionally. The natural dye has not commercially succeeded like synthetic dyes. Natural dye better result in staining of cotton cloth, silk fiber and cotton fiber. The dye is cheap, soothing, long lasthing and has antimicrobial property (Meena-Devi, Ariharan and Nagendra-Prasad, 2013).

CONCLUSIONS AND SUGGESTIONS

Based on the results obtained it can be concluded that:

1. Acacia wood surface staining has been made with a mixture of natural color (Gambier-betle leaves-areca seeds) and 0.5 grams of NaCl in 100 mL of water with the simultaneous method of mordanting for 15 minutes. The optimum mass ratio of the dye mixture obtained was 5.0: 3.0: 3.0 in brown and highest uptake average of 0.19 gram.
2. Ration of dye has the durability to 1% detergent and mass loss was obtained an average of 0.01, which is the smallest loss than the others and has the durability of the dye to detergents solution.

From the results obtained, it may be advisable to keep the addition of other auxiliaries (mordant) to the dye which is alkaline, acid and salt in order to obtain a varied color rendition.

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