THE USE OF CLOVE LEAVES *(Syzygium aromaticum L.)* AS NATURAL DYE FOR BATIK PRODUCTION IN KASUMEDANGAN BATIK INDUSTRY, INDONESIA

Bandi Sobandi[1], Triyanto[2], Tjetjep Rohendi Rohidi[3] and Syakir[2]

[1]*Universitas Negeri Semarang, Doctoral Degree Program in Arts Education, Semarang, Indonesia*
[2]*Universitas Negeri Semarang, Faculty of Language and Art, Fine Arts Education, Semarang, Indonesia*
[3]*Universitas Dian Nuswantoro, Faculty of Computer Science, Visual Communication Design, Semarang, Indonesia*
bas@students.unnes.ac.id; triyanto@mail.unnes.ac.id; trrohidi@yahoo.com, kirmuharrar@mail.unnes.ac.id

Abstract: *The use of synthetic dyes in the batik production process has an impact on environmental pollution and threatens human health. To overcome this problem, the use of natural dyes as materials for coloring batik cloth is one of the solutions offered. Apart from being environmentally friendly, the use of natural dyes is an effort to preserve ancestral traditions that have local wisdom and as an effort to utilize abundant natural resources. This study used a laboratory experimental method using one fixed variable, namely natural coloring agent from extracted clove leaves and two changing variables, namely the fixator in the form of ferrous sulfate ($FeSO_4$) and lime solution ($Ca(OH)_2$). The test parameters are color resistance through the washing process and color resistance by the solar radiation process. The research was conducted collaboratively between researchers and batik artisans at the Umy May Batik Studio in Tanjungsari, Sumedang Regency. The results showed a variation in color direction based on the type of natural dye and the type of fixator used. The color of Kasumedangan batik cloth in the Cadas Pangeran motif using clove leaf extract with two different fixators produces cream and dark brown colors. Based on the test results, the color resistance to washing 40°C shows the level of color resistance of clove leaves using the ferrous sulfate fixator is good (value 4-5 from a scale of 5) and lime solution fixator is categorized as good (value 4-5 from scale 5). Meanwhile, the results of the color fastness test to light: day light using ferrous sulfate were found to be categorized as quite fairly good (value 3-4 from a scale of 5) and using lime solution was categorized as good (value 4 from a scale of 5). Based on these results, it can be concluded that the clove leaf extract can be used as an environmentally friendly dye for batik cloth and has local wisdom and added value for batik craftsmen.*

Keywords: *clove leaves, Kasumedangan batik, patterned batik, environmentally friendly, natural dyes.*

1 INTRODUCTION

Indonesian batik has experienced rapid growth since its establishment by UNESCO as an intangible cultural heritage in the field of humanity. This recognition is achieved because batik originates from oral traditions and expressions, is used in social practices (rites and celebrations) and is a traditional craftsmanship [1]. Behind the improvement in batik products, new problems have emerged that threaten human health and environmental sustainability, especially water. The batik home industry, which is being developed, can increase environmental pollution of river water which is the main source of agricultural, fishery and drinking water activities [2]. The decline in the quality and quantity of available fresh water which results in harmful effects on human health and/or economic activity is a global issue facing the world community today [3].

Synthetic dyes are widely used by batik craftsmen today. In fact, synthetic dyes containing azo groups with amino aromatic properties are strongly suspected to cause skin cancer (carcinogenic), are toxic and can pollute the environment [4, 5]. Wastewater from the batik industry has an impact on large amounts of organic wastewater, has a thick color, a strong odor and temperature, acidity (pH), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Total Suspended Solid (TSS) in high levels, and is harmful to the environment if discharged directly into water [6, 7]. This is reinforced by the findings of the measurement results of batik industrial waste in five locations in the housing ditch in Pekalongan as one of the batik handicraft centers, with average data obtained: Cd 0.07 mg/L, Cr 0.76 mg/L and Pb 0.78 mg/L. These three parameters exceed the maximum level of quality standards stipulated by Government Regulation No. 82 of 2001 concerning water quality management and water pollution control [8].

In the past few years, the revival of natural colors is one of the solutions to reduce the impact of environmental pollution. This condition is a worldwide movement to protect the environment

from the process of exploration and pollution by industry. Natural dyes are compatible with nature due to their harmless properties and produce soft and silky colors [9]. The classification of natural dyes based on their source comes from plants (leaves, bark, flowers, fruits, etc.), animals (dried insects, shells of sea snail), minerals (rock, earth crust), and micro-organisms (fungi, algae, bacteria), etc.) [10]. The chemical compounds associated with this dye include carotenoids, flavonoids, tetrapyrroles and xanthophylls. These dyes are applied in the textile, food, pharmaceutical, cosmetic, handicraft and leather tanning industries recommended as a health and environmental awareness and industrial products that can be marketed [11]. Diversification of batik products with natural dyes is one way to create a luxurious effect on hand-made woven products for the changing fashion market, the use of natural dyes in the textile industry can make a valuable contribution to environmental sustainability in the 21st century [12]. However, in certain cases, behind the existence of environmental awareness, natural color batik production tends to be triggered by economic reasons, namely to maintain the economic survival of batik masters [13].

The use of natural dyes has advantages including being less toxic, less polluting, less health hazardous, non-carcinogenic, non-poisonous, more biodegradable, relatively safe, environmentally friendly and easy to obtain with zero liquid waste compared to synthetic variants. The remaining wastewater from the staining stage is then used for other processes, the remaining organic waste from the entire procedure is used as compost and for batik production [14-16]. These findings are in line with previous findings that liquid waste immersed in natural dye extract (ZPA) can be grouped into household groups, furthermore the value of synthetic dye pollution load (ZWS) is 7-20 times greater than natural dyes [17].

One of the potential plant parts for natural dye sources is the leaves. Some sources of natural colorants from leaves include: henna (*Lawsonia inermis L*), teak (*Tectona grandis*), malabar nut (*Adhatoda vasica nees*), chikrasi (*Chukrasia tabularis*), european lily (*Convallaria majalis*), Glastum (*Isatis tinctoria Linn*), mango bark (*Mangifera indica*), peach (*Prunus persica*), stinging nettle (*Urtica dioica*), fire flame bush (*Woodfordia fruticosa*), sweet indrajao (*Wrightia tinctoria*), safed kikar (*Acacia leucophloea*), neel (*Indigofera cassioides Rottl. Ex. DC.*), jamun (*Syzygium cuminii)* and ber (*Ziziphus mauritiana Lam*) [18]. Mango leaves have good potential for dyeing silk fabrics [19], Teak leaves (*Tectona grandis*) can be used for dyeing batik cloth [20]. Indigo (*Indigofera L*) is batik's natural blue dye extracted from the leaves of the indigo plant, which is environmentally friendly and non-carcinogenic [21] and *tanjung* leaf (*Mimusops elengi Linn*) can be an attractive choice for dyeing cotton and silk fabrics in various elegant shades [22]. In particular, several sources of natural dyes from leaves include medicinal plants and spices including leaves: tea (*Camellia sinensis L.*), betel (*Piper betle L*), eucalyptus (*Eucalyptus*), henna (*Lawsonia inermis L*), cardamom (*Elettaria cardamomum*), coral jasmine (*Nyctanthes arbor-tristis*), lemon grass, malabar nut (*Adhatoda vasica nees*) and chikrasi (*Chukrasia tabularis*) [23, 24, 18].

Clove (*Syzygium aromaticum L.*) is a tropical plant which is indigenous to Indonesia and has the ability to grow in several parts of the country including the lowlands, near the coast, and in the mountainous areas at an altitude of 900 m above sea level. These plants grow well when there is enough water and direct sunlight [25] and has also been observed to be a spice plant native to the Maluku Islands which has been traded and cultivated from one generation to another in the form of smallholder plantations. Clove contains saponins, alkaloids, flavonoid glycosides and tannins. Meanwhile, flavonoids are a type of toxic or allelopathic compound usually produced from flavones-bound sugar. The plant has a very sharp odor, bitter taste, soluble in water and organic solvents, and easily decomposes at high temperatures.

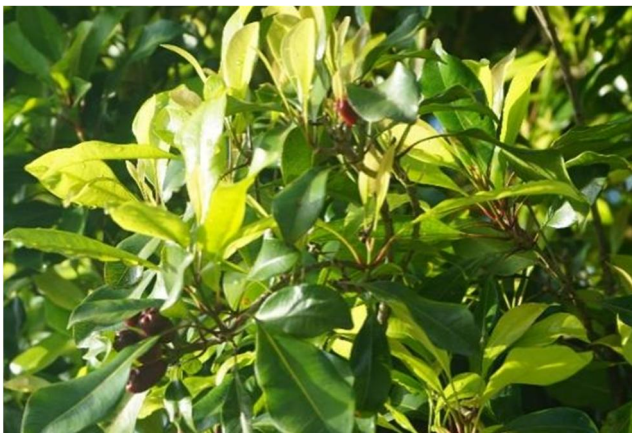

Figure 1 Clove leaves (*Syzygium aromaticum*); source: author's documents

Moreover, the natural herbicide effectiveness of clove leaf extracts at a concentration of 50% can be used as an alternative to inhibit the height growth of nutgrass weeds [26]. This plant represents one of the richest source of phenolic compounds such as eugenol, eugenol acetate and gallic acid and posses great potential for pharmaceutical, cosmetic, food and agricultural applications [27]. Clove is a spice plant that has long been used in the cigarette, food, beverage and medicine industries. The usable plant parts are flowers, flower stalks and clove leaves. The use of cloves has developed in the cosmetic industry and recently there have been several findings that the possibility

of developing the use of cloves for other purposes, including as an anesthetic agent for fish and the eradication of pests and plant diseases [28].

Various studies related to the benefits of cloves have been conducted. The presence of cloves as a native Indonesian plant is seen as the champion of all known antioxidants because it has antiseptic, antibacterial, antifungal, antimicrobial, antidiabetic, anti-inflammatory, hepatoprotective, anti-stress, antiviral and insect repellent properties. In the field of medicine, cloves have many uses such as for the treatment of toothache, inflammation of the mouth and throat, treating flatulence, nausea and vomiting and in certain doses can be used to induce anesthesia [29-31]. Apart from the health sector, cloves can also be used as a spice for spices and food preservatives [32, 33]. In particular, clove leaves also have medicinal benefits. Clove leaf oil contains 1-4% of oil by weight, the main component being eugenol (80-88%) with low eugenyl acetate and high content of caryophyllene [34, 35]. Clove leaf extract at a concentration of 10% was the most effective for avoiding fly infestation during the drying process of salted fish [36]. Leaves can be a candidate for producing active compounds to treat dental cavity because they contain bioactive compounds: 3-allyl-6-methoxyphenol-eugenol; caryophyllene 1,4,7-cycloundecatriene; 1,5,9,9-tetramethyl; phenol; 2-methoxy-4-(2-propenyl); and eugenol acetate [37]. Even the flavonoids from clove leaf oil have strong anticancer activity (IC50 <100 μg/mL) so that they are new candidates for liver cancer therapeutic agents [38].

The use of cloves in the fields of medicine, food, beverages, fisheries and agriculture has been widely practiced before both in Indonesia and in several countries as described above. However, the use of clove leaf waste as an extract material for natural dyes to dye batik cloth has not been widely explored, even though clove leaves have anti-microbial and environmentally friendly properties which are considered suitable for dyes in batik. Through this research, the authors want to find the benefits of clove leaves as a local plant that is often found in Indonesia to be used as a dye for batik cloth in the Kasumedangan Batik industry by observing how the color is produced using ferrous sulfate and lime solution fixation and how the color resistance test results are 40°C wash and color fastness to daylight.

In addition to efforts to introduce the benefits of cloves as a biological natural resource in Indonesia, this study was also conducted to expand previous research regarding the use of herbal extracts from cloves applied to fabrics by two methods, namely: Direct application method and Microencapsulation method which showed antimicrobial efficacy and resistance to washing by applying AATCC 147, AATCC Standard 30 and EN ISO 20645. Both treatments showed good antibacterial properties and the microencapsulation method also showed good antifungal properties. Through the direct application method, the washing resistance is only up to 10 washes, while the microencapsulation method shows excellent washing resistance of up to 30 wash cycles [39]. Extract solution of clove using water at 90°C for 90 minutes with an ingredient to water ratio of 1:10 shows that utilizing natural dyes from clove extract as a dyeing agent significantly facilitates obtaining a quality antibacterial cloth [40].

2 EXPERIMENTAL PART

2.1 Methods

This study examines the technology involved in developing natural and environmentally friendly colors for *Kasumedangan* batik dyeing at the Umy May Batik Studio in Tanjungsari, Sumedang Regency. The focus is on determining the technology to be applied by *Kasumedangan* batik craftsmen in batik cloth dyeing process by conducting tests on color resistance against washing and sun radiation. Laboratory experimental methods were implemented using the natural dye from extracted clove leaves as the dependent variable while fixators in the form of ferrous sulfate solution ($FeSO_4.7H_2O$) and lime solution ($Ca(OH)_2$) were used as the independent variables. In addition to using lime solution ($Ca(OH)_2$), the material for fixation or initial mordant can use cow bone ash which has a high potential to be used as a pre-mordant and fixator in the process of dyeing cotton and silk fabrics [41]. Meanwhile, the test parameters were color resistance values obtained against washing and sun radiation.

2.2 Materials

The raw materials used include clove (*Syzygium aromaticum L.*) leaves which were processed by extraction as well as *tunjung*/ferrous sulfate solution ($FeSO_4$) and lime solution ($Ca(OH)_2$) which were used as the fixing materials. Moreover, *tawas*/alum ($Al_2(SO_4)_3.K_2SO_4.24H_2O$), sodium carbonate and Turkey Red Oil (TRO) were applied for auxiliary immersion and *pelorodan* which is the process of removing wax sticking on the cloth. The tools used include a gas stove, a scale, a measuring cup, a dipping tub, a pot for the extraction of natural dyes, a tub for *pelorodan* process, and a color resistance test device through washing and sun radiation.

2.3 Work procedures

This section describes the steps starting from processing cotton fabrics, making natural color extracts from clove leaves, dyeing fabrics with natural color extracts, color fixing processes using *tunjung*/ferrous sulfate solution ($FeSO_4$) and lime solution ($Ca(OH)_2$), *pelorodan* process, testing

process, analysis of test results, and determining conclusions. Furthermore, the research steps are presented in Figure 2.

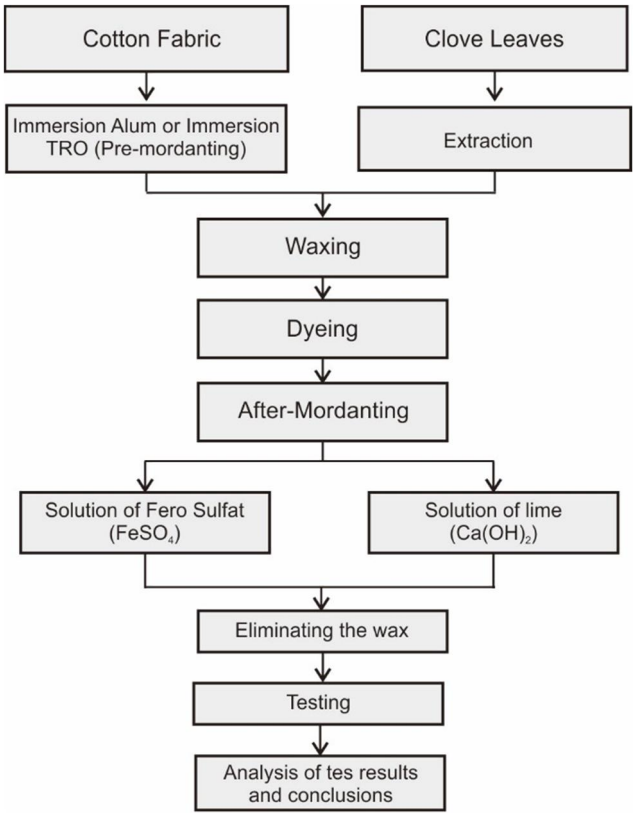

Figure 2 The work process of dyeing batik cloth with natural dye extracts from clove leaves

2.3.1 Preparation stage

There are two activities in the process of activities carried out at the preparation stage, namely:

1) Batik cloth processing

At this stage, the process of soaking the cloth is carried out with the TRO auxiliary substance or with alum solution (6 g/L) for 24 hours, then the cloth is rinsed and dried for the batik process. The use of TRO material aims to improve the quality of the absorption of the natural color of clove leaf extract on the batik cloth.

2) Natural dye processing

The process of processing natural colors into color extracts is carried out in the following stages:

a) Cut the natural dyestuff from the plants (such as: stems, barks, leaves, roots, flower, seeds, fruit and sticky plant-sap) into small and balanced pieces. It needs 1 kilogram the plants of natural dyes for 1-piece fabric (size 2.5 m, or equivalent 500 g).

b) Put the materials in a vessel; add 10 L of water into the vessel, then boiled until the water is about 4-5 L left. Filter the solution from the material after the extraction process.

c) Put the fabric (cotton or silk) to the mordant process (pre-mordanting).

d) Apply the TRO solution on the fabric then dry it before the coloring process with the natural dyestuff, namely *tawas* ($Al_2(SO_4)_3$ $K_2SO_4$24 H_2O) solution. Repeat the coloring process until the color is getting darker and then dry the fabric.

e) For the last process, the fabric put into “after mordant" or “*sarenan”* (Javanense process) solution, with *quick lime* ($Ca(OH)_2$), or with *tunjung*/ferro sulphate ($FeSO_4.7H_2O$), or with *tawas* ($Al_2(SO_4)_3.K_2SO_4$ H_2O) solution. After the color changes, dry it [42].

The activities carried out at this stage were the researchers boiled clove leaves with a ratio of 1 kg:10 L of water. The boiling process is carried out until the clove leaf dye extract becomes 5 L. The extraction of natural dye pigments can be carried out at various temperatures. Extraction of dye pigments simply by immersing the material in cold water for 24 hours, then heating to boiling (98-100°C), for heat sensitive dyes (usually dyes derived from flowers) to a temperature of 70-80°C [43]. Furthermore, this clove leaf extract material is ready to be used in the next fabric dyeing process.

2.3.2 Waxing process

Writing batik cloth with hot wax can be done using writing techniques using canting, canting cap or a combination of the two to form a batik ornament/pattern based on the desired batik motif design. In this research, the writing of batik cloth with wax uses a canting cap with the Cadas Pengeran batik motif.

2.3.3 Dyeing process

The process of dyeing batik cloth using natural dye extract from clove leaf material is done gradually and repeatedly. The batik cloth is then dyed in some water with enough TRO added so that the wetting process is faster and the dye is evenly distributed. After the cloth is removed, the cloth is hung so that there are no more water drops yet the cloth is still damp. The process of dyeing the batik cloth into the clove leaf extract solution is carried out for ±15 min, then the fabric is dried a little bit before being dyed again. The dyeing and drying process is repeated 5 times.

2.3.4 Fixation/mordanting process

The fixation process serves to determine the direction of the color and adjust the color on the fabric so that it doesn't fade quickly. The fixation auxiliary uses a solution of *tunjung*/ferrous sulfate ($FeSO_4$) with a composition of 30 g/L of lime solution ($Ca(OH)_2$) fixation with a composition of 50 g/L of lime. The two fixation solutions are set for 24 hours and the used part is the clear solution. *Tunjung* and chalk as a fixator function to create color and strengthen color resistance according to the type of metal that binds them and to lock the dye

that has entered into the fiber [44, 11]. The use of fixators in the form of heavy metals is very toxic and bad for the environment [45]. Several efforts have been made such as the electron beam radiation with Electron Beam Machine (MBE) which is currently being used as an alternative fixator in natural color batik dyeing process due to its environmental-friendliness, good quality which conforms with the SNI (Indonesian National Standard), and its ability to reduce the concentration of heavy metals in batik waste in order to create a sustainable batik industry [44].

2.3.5 Process of removing wax from batik cloth

The process of decaying the wax (*pelorodan*) of the batik cloth is carried out in boiling hot water on the stove at a temperature of 100°C. To the water, an auxiliary substance is added in the form of *soda ash*/natrium carbonate (Na_2CO_3) (5 g/L). The addition of auxiliary substances aims to make the wax easily separated from the batik cloth. After removing then wax, the cloth rinsed and then dried it.

2.3.6 Testing

The parameters used were color resistances against washing and sun radiation and they were tested at the Yogyakarta Institute of Batik and Handicraft, Yogyakarta. Batik cloth that has been dyed with clove leaf color extract and confirmed with a *tunjung*/ferrous sulfate ($FeSO_4$) solution and lime solution ($Ca(OH)_2$) then two test methods are carried out, namely:

1) Color fastness resistance to washing 40°C (SNI ISO 105 - C06: 2010. Textiles - Color fastness test method - Part C06: Color fastness against household and commercial washing, "2010). In this method, the color change value is also tested (SNI ISO 105-A02:2010. Textiles - Test for colour fastness - Part A02: Grey scale for assessing change in colour (ISO 105-A02:1993, IDT)) and color staining value (SNI ISO 105-A03:2010. Textiles - Tests for colour fastness - Part A03: Grey scale for assessing staining (ISO 105-A03:1993, IDT)).
2) Color fastness resistance to sunlight ("SNI ISO 105 - B01: 2010. Textiles - Color fastness test method - Part B01: Color fastness to light, sun light" 2010), wavelength testing, and absorbance using spectrophotometry. In this method, the color change value is also tested (SNI ISO 105-A02:2010. Textiles - Test for colour fastness - Part A02: Grey scale for assessing change in colour (ISO 105-A02:1993,IDT))

2.3.7 Analysis of test results and conclusions

The test results of color fastness against washing at 40°C and color fastness to light: sun light using ferro sulfate and lime fixation were then analyzed and concluded. Data analysis results and conclusions will be presented in section 3.

3 RESULTS AND DISCUSSION

3.1 *Batik Kasumedangan motif*

Kasumedangan batik development has its own uniqueness. Behind the development process, there is a myth in the form of prohibition/taboo for some people to wear batik. This condition arose since the conflict between the Sumedang Larang Kingdom and the Cirebon Sultanate in the past through the oath of Eyang Jaya Perkosa. This belief continues to this day, every person who goes on a pilgrimage to Patilasan Leluhur Sumedang in the Dayeuh Luhur area is not allowed to wear batik clothes.

The Kasumedangan batik motif design creations come from the physical environment, cultural, social, artistic artifacts and philosophical values of the supporting community. This condition is in line with the view that the visualization and structure of batik motifs that developed from regional icons at the time of making cloth and clothing is now a trend for Indonesian batik [45]. In addition to the initiative and creativity of batik craftsmen, society and community participation, the development of Kasumedangan batik is also closely related to local government support through Regent Regulation No. 113 of 2009 concerning *Sumedang Puseur Budaya Sunda* (SPBS) which explicitly regulates the use of *Kasumedangan* Ornamental Variety, such as: *Binokasih Crown*, *Kujang*, Pajajaran Ornamental Variety, *Lingga*, *Garuda Mungkur*, *Manuk Julang*, *Naga*, *Hanjuang*, *Kembang Cangkok Wijaya Kusumah*, and Lotus.

3.2 *Results of dyeing Kasumedangan batik cloth with clove leaf color extract*

The process of coloring the batik cloth was carried out on the Cadas Pangeran batik motif as one of the Kasumedangan batik motif creations made by the Umy May Batik Studio, in Tanjungsari, Sumedang. The visualization of this motif was inspired by a place and the figure of Pangeran Kornel (Pangeran Kusumadinata IX, Sumedang Regent 1971-1828 was built) shaking hands with Daendels. The results of the coloring of the batik cloth using natural dye extract of clove leaves with different fixers, resulting in different directions and colors.

The results of dyeing batik cloth using dye extracts from clove leaves with the *tunjung*/fixation solution tend to be brown towards black (Figure 3), while the use of lime fixation tends to beige towards brown (Figure 4). Thus, one of the functions of the fixator is to determine the direction of the color. The use of extracts from the same material will produce different colors when using different fixators.

Figure 3 Natural dye of clove leaves in the Cadas Pangeran batik motif by ferro sulfate fixation, source: author's documents

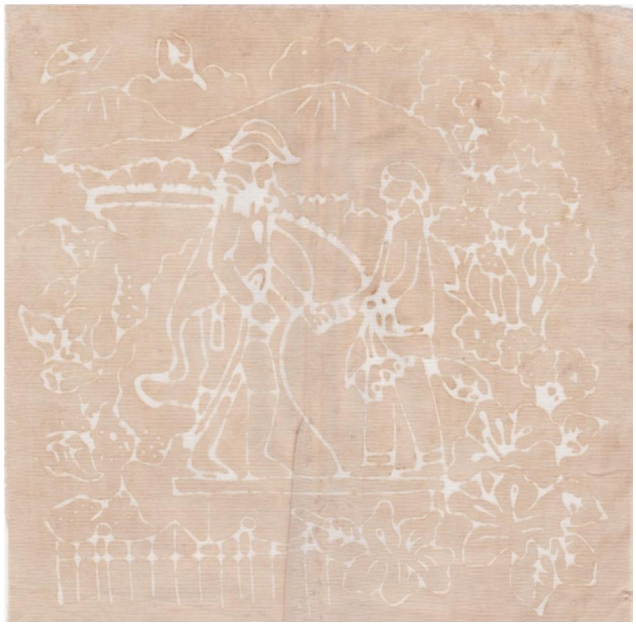

Figure 4 Natural dye of clove leaves in the Cadas Pangeran batik motif lime fixation; source: author's documents

The findings above are in line with the opinion that the fixation material in addition to strengthening the bonds of natural dyes with the fabric also greatly determines the different color directions. Alum produces a light color according to its original color, medium lime or brownish direction, not older or leads to black [46]. The higher the concentration of the fixator, the stronger the color produced because the function of the fixator is not only to cause color but also to strengthen the bonds between fibers and colors so as to prevent dehydration of color pigments [47]. According to Barber (1991), "A mordant is a separate chemical that combines with the dye in such a way as to attach the coloring matter to the fiber by increasing affinity and/or strengthened interactions in some cases via a lasting chemical bond (mordant means 'biting in'), thereby making the color stand fast against light and washing" [23]

3.3 Color fastness resistance test results

The result of the batik dyeing process that is applied in the process of dyeing the Cadas Pangeran batik cloth as one of the names of the *Kasumedangan* batik motif. Color fastness testing using a test method based on SNI ISO 105-C06: 2010, Textiles-Color fastness test method-Part C06: Color fastness to household and commercial washing and SNI ISO 105-B01-2010, Textiles-Durability test method color fastness - Part B01: Light fastness: Daylight fastness. The reading of the test results is in the form of a gray scale for color staining and color changes on a scale of 1 to 5, in the form of a value of 5 (very good), value 4 (good), value 3 (moderate), value 2 (bad) and value 1 (very bad). The results of the fastness test of cotton batik cloth with clove leaf color against washing and sunlight are presented in Table 1.

Table 1 Natural color resistance of clove leaves

No.	Test type	Test results (fixator type)		Test method
		$FeSo_4$	$CaCo_3$	
1.	Washing resistance 40°C Color change value Color blemishes value - acetate - cotton - polyamide - polyester - acrylate - wool	4-5 4-5 4 4-5 4-5 4-5 4-5	4-5 4-5 4-5 4-5 4-5 4-5 4-5	SNI ISO 105-C06:2010 SNI ISO 105-A02:2010 SNI ISO 105-A03:2010
2.	Color resistance to light: day light Ray resistant value	3-4	4	SNI ISO 105-B01:2010 SNI ISO 105-B02:2010

Description: 1 = very bad, 1-2 = bad, 2 = bad, 2-3 = moderate, 3 = moderate, 3-4 = fairly good, 4 = good, 4-5 = good, 5 = very good

Table 1 above is the data on the results of testing the natural color of clove leaves applied to the Cadas Pengeran batik motif. The process of immersing the clove leaf extract by immersing the cold technique was carried out five times, which was then confirmed with a solution of ferrous sulfate ($FeSO_4$) and/or lime solution ($Ca(OH)_2$), the results were:

1) Wash fastness 40°C. The batik coloring on the cotton cloth uses the natural color of clove leaves in the cold dyeing method about 5 times dyeing. Based on the table above, it is known that the color fastness resistance to washing is 40°C through the SNI ISO 105 - C06: 2010 testing technique. Textiles - Color fastness test method - Part C06: Color fastness against household and commercial washing, "2010) then the dyeing results batik cloth that uses fixation with *tunjung*/ferro sulfate solution and lime solution fixation is known to be categorized as good (score 4-5 on a scale of 5). Likewise, the value of color change (SNI ISO 105-A02: 2010. Textiles - Test for color fastness - Part A02: Gray scale for assessing change in color (ISO 105-A02:1993, IDT)) and color staining value (SNI ISO 105-A03:2010. Textiles - Tests for colour fastness - Part A03: Grey scale for assessing staining (ISO 105-A03:1993, IDT), these results indicate that the natural dyes from clove leaf extract are categorized as good - very good. From the results of this test it can be concluded that clove leaf extract can be used as a quality dye for batik cloth.
2) Light fastness resistance: day light. The results of the color fastness test to light: day light (SNI ISO 105-B01: 2010) by using the *tunjung*/ferrous sulfate solution were known to be in the fairly good category (score 3 - 4 from a scale of 5) and by using the lime solution in the good category (score 4 from a scale of 5). The same value was also obtained in the Light-resistant value test (SNI ISO 105-A02: 2010. Textiles - Test for color fastness - Part A02: Gray scale for assessing change in color (ISO 105-A02: 1993, IDT)). The results of these findings can be concluded that the use of clove leaf extract has quality light resistance values ranging from moderate to good category.

Based on the findings above, it can be concluded that the use of clove leaf waste as an extract material for natural colors can be used as an alternative to natural dyes for quality and environmentally friendly dyes for batik cloth. The use of abundant clove leaf waste to extract batik dyes is an effort to raise the value of local wisdom through the use of traditional plant commodities that have long and thrived in Indonesia as spices. Not only that, the use of natural colors in the coloring process of batik cloth can increase the economic added value of today's batik craftsmen.

To get a different gradient color, it can be done in several ways, including: 1) adjust the amount of dyeing the batik cloth, the more dyeing process, the stronger the color intensity; 2) adjusting the ratio of the amount of dye and cooking water used (usually 1 kg/10 L), the more the proportion of natural ingredients used, the stronger the color intensity; 3) the time of dyeing the fabric in the color extract, the longer the dyeing time, the stronger the color intensity. In order to obtain the variation and intensity of the batik cloth dyeing results with clove leaf extract, further research is needed, such as the methods above.

4 CONCLUSION

The use of natural color substances in the coloring of batik cloth is the right solution in reducing the current problem of environmental pollution. Processing natural color substances by using the final mordant as a fixator can provide direction and type of color on *Kasumedangan* batik cloth. The test results with the method of testing the resistance of fading to 40°C washing on batik cloth with Cadas Pangeran motif by using clove leaf extract with ferro sulfate and lime fixations are categorized good-very good. Similarly, the test results with the method of color fading resistance to light: day light using *tunjung* fixation is known to be categorized moderate-good and with a good category with lime fixation. Thus, this study recommends the need to use natural color substances from clove leaf extract material for batik fabric dyes as an effort to preserve the value of local wisdom and give added value to *Kasumedangan* batik craftsmen.

ACKNOWLEDGMENT: *The authors would like to thank the Manager of The Domestic Postgraduate Education Scholarship (BPPDN), Directorate General of Science, Technology Resource and Higher Education for the assistance of funds in the further study of the Doctoral Program of the Art Education Study Program for researchers.*

5 REFERENCES

1. UNESCO: Indonesian Batik - Inscribed in 2009 (4.COM) on the Representative List of the Intangible Cultural Heritage of Humanity, 2009, https://ich.unesco.org/en/RL/indonesian-batik-00170
2. Koosdaryani, Masykuri M., Purwanto E., Suranto: Batik industry wastewater treatment using fito remidiation of water hyacinth with adsorbent consist of organic waste bagasse, rice husks and bamboo charcoal, IOP Conference Series: Materials Science and Engineering, 508 012111, 2019, pp. 1-6, https://doi.org/10.1088/1757-899X/508/1/012111
3. World Economic Forum: The Global Risks Report 2020, 15th edition, http://www3.weforum.org/docs/WEF_Global_Risk_Report_2020.pdf

4. Lestari K., Riyanto R.: The making of blue natural dye from Indigofera Tinctoria (Pembuatan Pewarna Alam Biru dari Indigofera Tinctoria), Dinamika Kerajinan dan Batik No.21, 2004, pp. 7-15 (in Indonesian)
5. Kant R.: Textile dyeing industry an environmental hazard, Natural Science 4(1), 2012, pp. 22-26, doi: 10.4236/ns.2012.41004
6. Kurniawan M.W., Purwanto P., Sudarno S.: Sustainable wastewater management strategy of batik MSME Center in Sukoharjo Regency (Strategi Pengelolaan Air Limbah Sentra UMKM Batik yang Berkelanjutan di Kabupaten Sukoharjo), Jurnal Ilmu Lingkungan 11(2), 2013, pp. 62-72, (in Indonesian) https://doi.org/10.14710/jil.11.2.62-72
7. Tangahu B.V., Ningsih D.A., Kurniawan S.B., Imron M.F.: Study of BOD and COD removal in batik wastewater using Scirpus grossus and Iris pseudacorus with intermittent exposure system, Journal of Ecological Engineering 20(5), 2019, pp. 130-134, https://doi.org/10.12911/22998993/105357
8. Budiyanto S., Anies, Purnaweni H., Sunoko H.R.: Environmental Analysis of the Impacts of Batik Waste Water Polution on the Quality of Dug Well Water in the Batik Industrial Center of Jenggot Pekalongan City, E3S Web of Conferences 31, 2018, pp. 1-7, https://doi.org/10.1051/e3sconf/20183109008
9. Saxena H.O., Tiwari R., Pandey A.K.: Optimization of extraction and dyeing conditions of natural dye from Butea monosperma (lam.) kuntze flowers and development of various shades, Environment & We an International Journal of Science & Technology 7, 2012, pp. 29-35
10. Adeel S., Rafi S., Mustaan M.A., Salman M., Ghaffar A.: Animal Based Natural Dyes: A Short Review, chapter 4 in Handbook of Renewable Materials for Coloration and Finishing, Yusuf M. (Ed.), Beverly: Scrivener Publishing, 2018, 46 p., https://doi.org/10.1002/9781119407850.ch4
11. Pujilestari T.: The effect extraction method and fixation of natural dyes to color fastness on cotton fabric (Pengaruh Ekstraksi Zat Warna Alam dan Fiksasi Terhadap Ketahanan Luntur Warna pada Kain Katun), Dinamika Kerajianan dan Batik 31(1), 2014, pp. 31-40 http://dx.doi.org/10.22322/dkb.v31i1.1058 (in Indonesian)
12. Maulik S.R., Bhowmik L., Agarwal K.: Batik on handloom cotton fabric with natural dye, Indian Journal of Traditional Knowledge 13(4), 2014, pp. 788-794, http://nopr.niscair.res.in/handle/123456789/29531
13. Handayani W., Kristijanto A.I., Hunga A.I.R.: Behind the eco-friendliness of "batik warna alam", Discovering the motives behind the production of batik in Jarum village, Klaten, Wacana 19(1), 2018, pp. 235-256, http://dx.doi.org/10.17510/wacana.v19i1.673
14. Siva R.: Status of natural dyes and dye-yielding plants in India, Current Science 92(7), 2007, pp. 916-925, https://www.jstor.org/stable/24097672
15. Pujilestari T.: Review: Source and utilization of natural dyes for industrial use (Review: Sumber dan Pemanfaatan Zat Warna Alam untuk Keperluan Industri), Dinamika Kerajinan dan Batik 32(2), 2015, pp. 93-106, http://dx.doi.org/10.22322/dkb.v32i2.1365 (in Indonesian)
16. Martuti N.K., Hidayah I., Margunani M., Alafima R.B.: Organic material for clean production in the batik industry: A case study of natural batik Semarang, Indonesia, Recycling 5(4), 2020, pp. 1-13, https://doi.org/10.3390/recycling5040028
17. Lestari K.W., Sulaeman: Research on the value of pollution load on some extracts of natural dyes (Penelitian Nilai Beban Pencemaran pada Beberapa Ekstrak Zat Warna Alam), Dinamika Kerajinan dan Batik, 18, 2001, pp. 14-18 (in Indonesian)
18. Singh R., Srivastava S.: A critical review on extraction of natural dyes from leaves, International Journal of Home Science 3(2), Part B, 2017, pp. 100-103
19. Uddin M.G.: Extraction of eco-friendly natural dyes from mango leaves and their application on silk fabric, Textiles and Clothing Sustainability 1(7), 2015, pp. 1-8, https://doi.org/10.1186/s40689-015-0007-9
20. Satria Y., Suheryanto D.: The Effect of natural dyes teak leaves extraction temperature to the quality and color direction in batik (Pengaruh Temperatur Ekstraksi Zat Warna Alam Daun Jati terhadap Kualitas dan Arah Warna pada Batik), Dinamika Kerajinan dan Batik 33(2), 2016, pp. 101-110, http://dx.doi.org/10.22322/dkb.v33i2.1628 (in Indonesian)
21. Handayani P.A., Mualimin A.A.: Batik natural dye from nila plants (indigofera) with acid catalyst (Pewarna Alami Batik dari Tanaman Nila (Indigofera) dengan Katalis Asam), Jurnal Bahan Alam Terbarukan 2(1), 2013, pp. 1-6 (in Indonesian)
22. Hossain S., Jalil M.A., Bin Kamal S.A., Kader A.: A natural dye extracted from the leaves of Mimusops Elengi Linn and its dyeing properties on cotton and silk fabrics, Journal of Textile Institute 112(3), 2020, pp. 455-461, https://doi.org/10.1080/00405000.2020.1763057
23. Linh H.T.: Natural Dyes in Eastern Asia (Vietnam and Neighbouring Countries), chapter 6 in Handbook of Natural Colorants, Bechtold T., Mussak R. (Eds.), West Sussex: John Wiley & Sons Ltd, 2009, 66 p., https://doi.org/10.1002/9780470744970.ch6
24. Samanta A.K., Konar A.: Dyeing of Textiles with Natural Dyes, chapter 3 in Natural Dyes, Kumbasar E.A. (Ed.), InTech, 2011, pp. 29-56, http://www.intechopen.com/books/natural-dyes/dyeing-of-textiles-with-natural-dyes
25. Armando R., Asman A.: Producing 15 quality essential oils (Memproduksi 15 Minyak Atsiri Berkualitas), Penebar Swadaya, Jakarta, 2009, ISBN: 978-979-002-363-5 (in Indonesian)
26. Talahatu D.R., Papilaya P.M.: Utilization of clove leaf extract (Syzygium Aromaticum l.) as a natural herbicide against the growth of weeds puzzle grass (Cyperus Rotundus L.) (Pemanfaatan Ekstrak Daun Cengkeh (Syzygium Aromaticum l.) sebagai Herbisida Alami terhadap Pertumbuhan Gulma Rumput Teki (Cyperus Rotundus L.), Jurnal BIOPENDIX: J. Biologi Pendidikan dan Terapan 1(2), 2015, pp. 149-159, https://doi.org/10.30598/biopendixvol1issue2page160-170 (in Indonesian)
27. Cortés-Rojas D.F., de Souza C.R.F., Oliveira W.P.: Clove (Syzygium aromaticum): a precious spice, Asian Pacific Journal of Tropical Biomedicine 4(2), 2014, pp. 90-96, doi10.1016/S2221-1691(14)60215-X

28. Nurdjannah N.: Diversification of clove use (Diversifikasi Penggunaan Cengkeh), Perspektif Review Penelitian Tanaman Industri 3(2), 2004, pp. 61-70, http://dx.doi.org/10.21082/p.v3n2.2004.61-70 (in Indonesian)
29. Milind P., Deepa K.: Clove: a champion spice, International Journal of Research in Ayurveda Pharmacy 2(1), 2011, pp. 47-54, https://ijrap.net/admin/php/uploads/360_pdf.pdf
30. Ayushi, Khan U.A., Danish S.M., Mohamad, Parveen U.: A review on biological and therapeutic uses of Syzygium aromaticum Linn. (Clove): Based on phyto-chemistry and pharmacological evidences, International Journal of Botany Studies 5(4), 2020, pp. 3339, http://www.botanyjournals.com/archives/2020/vol5/issue4/5-3-115
31. Sharma R.K., Jha K.K.: Phytochemistry, pharmacology & medicinal importance of clove: a review, International Journal of Pharma Professional's Research 6(3), 2015, pp. 1283-1291, https://www.ijppronline.in/index.php/IJPPR/article/view/131
32. Gosavi N.S., Koli S.S., Jire D.S., Shaikh A.Z.: Clove (Syzygium Aromaticum): A Miraculous Spice, American Journal of PharmTech Research 8(5), 2020, pp. 1-17, doi: 10.46624/ajphr.2020.v8.i5.001
33. Batiha G.E.S., Alkazmi L.M., Wasef L.G., Beshbishy A.M., Nadwa E.H., Rashwan E.K.: Syzygium aromaticum l. (myrtaceae): Traditional uses, bioactive chemical constituents, pharmacological and toxicological activities, Biomolecules 10(2), 2020, pp. 1-17, doi: 10.3390/biom10020202
34. Nurdjannah N., Bermawie N.: Cloves, chapter 11 in Handbook of Herbs and Spices, Vol. 1, 2nd edition, Peter K.V. (Ed.), Woodhead Publishing, 2012, pp. 197–215, ISBN: 978-0-85709-039-3
35. Handayani P.A., Sofiarani A.W., Kurniawan A.B.: Response surface optimization of essential oils production from clove leaf waste by microwave-assisted hydro distillation, Journal of Physics: Conference Series 1444, 2020, https://doi.org/10.1088/1742-6596/1444/1/012006
36. Indriasih M., Cahaya I., Ashar T.: The utilization of clove leaf (Syzigium aromaticum) extract to reduce the flies' infestation during the salted fish-drying process (Pemanfaatan Ekstrak Daun Cengkeh (Syzigium Aromaticum) sebagai Repellent Nabati dalam Mengurangi Jumlah Lalat yang Hinggap Selama Proses Penjemuran Ikan Asin), Lingkungan dan Keselamatan Kerja 2(3), 2013, pp. 1-10, https://jurnal.usu.ac.id/index.php/lkk/article/view/3285 (in Indonesian)
37. Suhendar U., Sogandi S.: Identification of bioactive compounds in clove leaves (Syzygium Aromaticum) extract as inhibitor Streptococcus Mutans (Identifikasi Senyawa Aktif Ekstrak Daun Cengkeh (Syzygium Aromaticum) sebagai Inhibitor Streptococcus Mutans), AL-KAUNIYAH: Jurnal Biologi 12(2), 2019, pp. 229-239, https://doi.org/10.15408/kauniyah.v12i2.12251 (in Indonesian)
38. Tejasari M., Respati T., Trusda S.A.D., Hendryanny E., Yuniarti L.: Comparison of flavonoid from clove leaf oil cytotoxic activities with doxorubicin and cisplatin on liver cancer cell culture, Journal of Physics: Conference Series 1469, 2020, pp. 1-5, https://doi.org/10.1088/1742-6596/1469/1/012018
39. Ramya K., Maheshwari V.: Analysis of the anti-microbial efficacy of bamboo/cotton knitted fabric finished with the extracts of the Syzygium aromaticum buds, Journal of Textile Science & Engineering 3(3), 2013, pp. 1-5, doi: 10.4172/2165-8064.1000134
40. Lee Y.H., Hwang E.K., Kim H.D.: Colorimetric assay and antibacterial activity of cotton, silk, and wool fabrics dyed with peony, pomegranate, clove, Coptis chinenis and gallnut extracts, Materials (Basel) 2(1), 2009, pp. 10-21, doi: 10.3390/ma2010010
41. Bahari N., Handayani R., Santoso R.E., Prameswari N.S.: Mordant and fixation test of bone ash on natural colours towards cotton and silk fabric, Vlakna a Textil (Fibres and Textiles) 27(4), 2020, pp. 8-16, http://vat.ft.tul.cz/2020/4/VaT_2020_4_2.pdf
42. Suheryanto D., Haryanto T., Rahayu S., Setiadji U., Masiswo, Sudjaka, Hariyati, Budiarti I.: Natural Dyes, Yogyakarta: Institute of Batik and Handicraft Yogyakarta, 2007
43. Visalakshi M., Jawaharlal M.: Healthy hues – status and implication in industries – brief review, Research & Reviews: Journal of Agriculture and Allied Sciences 2(3), 2013, pp. 42-51, http://www.rroij.com/open-access/healthy-hues--status-and-implication-in-industries--brief-review.php?aid=33810
44. Indrayani L., Andriyati W., Nuraini E., Triwiswara M.: Application of Electron Beam Machining (EBM) as alternative fixator for batik with natural dyes (Aplikasi Mesin Berkas Elektron (MBE) sebagai Alternatif Fiksator pada Pewarnaan Batik Warna Alam), Dinamika Kerajinan dan Batik 37(1), 2020, pp. 105-118, (in Indonesian) http://dx.doi.org/10.22322/dkb.v37i1.6199
45. Sugiarto E., bin Othman A.N., Triyanto, Febriani M.: Regional icon motifs: Recent trends in Indonesia's batik fabric development, Vlakna a Textil (Fibres and Textiles) 27(1), 2020, pp. 93-98, http://vat.ft.tul.cz/2020/1/VaT_2020_1_14.pdf
46. Budiyono, Sudibyo W., Herlina S., Handayani S., Parjiyah, Pudiastuti W., Syamsudin, Irawati, Parjiyati, Palupi D. S.: Textile Craft for SMK Volume 1 (Kriya Tekstil untuk SMK Jilid 1), Direktorat Pembinaan Sekolah Menengah Kejuruan, Ditjen Dikdasmen Depdiknas, Jakarta, 2008, 72 p., ISBN: 978-602-8320-66-5 (in Indonesian)
47. Suheryanto D., Haryanto T.: The effect of alum concentration on the age and durability of color fastness in dyeing silk fabric with gambir dyes (Pengaruh Konsentrasi Tawas terhadap Ketuaan dan Ketahanan Luntur Warna pada Pencelupan Kain Sutera dengan Zat Warna Gambir), Dinamika Kerajinan dan Batik, 25, 2008, pp. 9-16, http://dx.doi.org/10.22322/dkb.v25i1.1023.g869 (in Indonesian)