AN ECO-FRIENDLY DYE FOR BATIK CLOTHES: A NATURAL DYE SOLUTION MADE OF MANGO SEEDS EXTRACT (*Mangifera indica L.*)

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ABSTRACT

Waste pollution resulting from the production process of synthetic batik dyes is against the Sustainable Development Goals (SDGs) in the aspects of waste management systems and clean water. One effort to cut down the amount of pollution is the use of natural dyes for coloring batik clothes. This undertaking is not only healthy but also expected to bring in some added value economically, community empowerment, and intergenerational inheritance. This experimental research was carried out collaboratively between the Textile and Batik Craft Studio at the Indonesian University of Education, the Umymay Batik Studio, and the Yogyakarta Batik and Craft Center. A batik cloth was dyed 5 times with a mango seed extract solution as the dependent variable, then fixed with lime solution ($Ca(OH)_2$) and Ferrous Sulfate solution ($FeSO_4.7H_2O$) as the independent variables. The dyed fabrics were tested for their colorfastness against washing and sun exposure. The results of the study: 1) The process of dyeing the batik cloth was performed through several stages, that is, by cutting the cloth with a canting stamp, dyeing the cloth, and fixing it with $Ca(OH)_2$ and $FeSO_4.7H_2O$, the batik cloth fixed with $Ca(OH)_2$ tended to be brown in color while the other one fixed with $FeSO_4.7H_2O$ resulted in black; 2) The results of the Color Fastness Test against Washing at 40℃ on the batik cloth that has been dyed with mango seed extract fixed with $Ca(OH)_2$ and $FeSO_4.7H_2O$ were considered a good category with respective values of 4 on a scale of 5. Likewise, the results of the Color Resistance to Light: Day Light Ray Resistant Test Value with the fixation of $Ca(OH)_2$ and $FeSO_4.7H_2O$ was in the moderate category with a value of 3 each on a scale of 5. There should be a governmental policy to promote a green industry. As for batik artisans, they can utilize an eco-friendly alternative dye for batik clothes.

KEYWORDS

Mangifera indica L.; Batik; Eco-friendly; Natural Dyes; SDGs.

INTRODUCTION

Humans have created textile products with various techniques to meet their needs, improve lives, and adorn the surface of fabrics [1]. Historically speaking, since ancient times, natural dyes have been frequently used to color textiles [2]. However, along with the increasing public demand for textile and batik materials and products, a new problem arises, namely environmental pollution polluted by waste/wastewater produced by the process and production of textile and batik companies [3], [4]. The use of fabric dyes with synthetic materials that have no guidelines has been confirmed as a major cause of pollution that harms human health and the environment [5]. The problem of environmental pollution as a result of the use of synthetic colors in the production of batik is currently under the spotlight of various parties. Handayani, et al reported that pollution caused by synthetic dyes and the problem of excessive water use by the home-based batik industry has raised water scarcity problems [6]. The need for efforts to conserve natural resources, such as water, soil, air, and others, is one of the goals of the SDGs. Lack of environmental education, an open mindset, socio-cultural practices in making batik, and the consideration of production costs appear to have affected the awareness of environmental sustainability among batik entrepreneurs, batik industry waste is not well processed yet rather disposed into waterways resulting in water pollution [7]. For this reason, genuine efforts are needed by the government, batik artisan communities, and the community to build citizen awareness through environment-based education, understanding the

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dangers of synthetic waste and how to overcome it and finding alternative solutions through the use of environmentally friendly natural dyes in batik production. The shared view of protecting the environment implies that meeting the needs of our present and future generations needs to be identified and pursued by cutting back on the production of waste and the use of toxic materials, to prevent soil, water, and air pollution and to conserve and reuse resources wisely [8].

One of the efforts to reduce such environmental pollution is through the production concept of naturally dyed batik emphasizing the crucial role of sustainable production. According to Pedro, et al, replacing chemicals with natural materials is not only healthy and safe but also in practice there lie the so-called aspects of empowerment and passing on skills to the next generation [9]. This goes hand in hand with public demand for the textile industry to utilize natural dyes that are more functionally advanced, without harmful effects on the environment and aquatic ecosystems [10]. In particular, the attitude and satisfaction factors of producers have a significantly positive effect on the intention to produce naturally dyed batik products. In addition, producer attitudes and satisfaction are also significantly influenced by social values, quality values, and green industry values 11.

Mango (*Mangifera indica L.*) is a type of tropical fruit notable worldwide for its production, distribution, marketing, and use for human health. Even mango waste (such as the seeds and skin) has high functional and nutritional potentia [12]. More than 38 million tons of this type of fruit are produced and traded in the world every year, currently, mango seeds are being re-evaluated as a potential food source of functional ingredients because of their composition in proteins, antioxidant compounds, and lipids [13]. Mango seed kernel flour (MSKF) has the potential to be a good source of nutrients for humans and antioxidants, and its composition consists of carbohydrates (36.2-39.3%), crude protein (5.2-6.6%), total lipids (5.9-7.2%), natural fiber (2.2-2.5%), and ash content (2.9-5.5%) [14]. The results of other studies report that the composition of mango seeds kernels (MSK), which contains carbohydrate sources (58-80%), protein (6-13%) and fat (6-16%), can be used for poultry food [15]. Mango fruit as a member of the Anacardiaceae family is widely grown and produced in countries such as India, China, Thailand, Indonesia, Pakistan, Mexico, Brazil, Bangladesh, Nigeria, and the Philippines [16].

Mango by-products, especially the seeds, and the peels, are considered valuable sources of food and medicinal and inexpensive nutraceutical ingredients for the food, pharmaceutical, nutraceutical, and cosmetic industries, with antioxidant, anti-inflammatory, immunomodulatory, antibacterial, antidiabetic, antiobesity, anti-inflammatory effects, and anticancer was highlighted [17],[18]. In particular, studies related to mango seeds have been carried out by many experts in their fields. In food studies, Mango seed kernel (MS) has total phenolic compounds, total lipids, non-saponifiable material, and crude protein, all of which are significant, but the quality of the protein is good because it is abundant in all important amino acids [19]. Mango seeds which represent between 20-60% of the fruit also have limited food or industrial use in most producing countries and are therefore wasted. The kernel contained in the seeds (mango seed kernel: MSK) is a good source of carbohydrates (58-80%), contains moderate amounts of protein (6-13%), and has a fat content (6-16%) [15]. Meanwhile, a study of mango seeds in the area of medicine found that mango seeds are a by-product that is usually discarded even though they are identified as a natural source of phenolic compounds with health-promoting activities as well as multifunctional bioactive ingredients for nutraceutical and cosmeceutical applications [20],[21],[22]. The effect of the ethanolic extract contained in mango seeds can restore tissue damage in acutely injured hind limb ischemia in diabetic rats [23].

The waste of the mango fruit production (with special regard to the seeds and skin) can be used for the sake of environmental preservation and renewable energy. Mango waste products are used in bioremediation studies of chromium contamination as a potential sorbent for removing Cr(VI) from aqueous solutions [24]. Mango Peel Waste (MPW) which has a high content of pectin and cellulose, offers potential use as an effective adsorbent to remove toxic metal ions such as Cd2+ and Pb2+, dyes, and other organic matter from water solutions in industrial waste [25]. Mango seeds are a viable source of bioactive compounds which can be recovered by a water-ethanol binary solvent system [26]. The activated carbon was made from the shells of mango seeds and is used as a CO2 adsorbent [27]. Mango seed extract can be used successfully in water purification processes [28]. In particular, mango seed husks as a by-product of the mango industry can also be explored and have some potential in the production of bioethanol, the use of this waste material allows added value because it can serve as an alternative and affordable source of raw materials in energy production [29].

The aforementioned studies delineate that many experts from various disciplines have discussed the benefits and uses of mango seeds for humans. Mango seeds can be developed as food and pharmaceutical ingredients, in the domain of environmental protection as a potential sorbent material with the ability to absorb some pollutants from the environment, such as heavy metals and dyes, bioethanol material which functions as an alternative raw material source in the energy sector. However, there seems to be no research discussing the benefits of mango seeds as natural dyes for batik

Fig 1. Mango Seed Materials (*Magnifera indica L.*).

cloth that are environmentally or eco-friendly and have not been widely explored. For this vacancy, the author intends to study and explain the benefits of mango seed as a by-product of mango fruit to be used as a natural dye for batik cloth that can be developed by batik artisans and entrepreneurs in Indonesia and other countries.

Mango seeds are in the protection of the skin and the mango fruit that covers them. Furthermore, mango seeds are also located inside a hard seed coat (endocarp) with various sizes (see Figure 1). From these seeds grow fibers that can sometimes penetrate into the flesh of the fruit resulting a fibrous flesh. According to Mukherjee & Litz, mango seeds are solitary, large and flat, oval-ovate, and surrounded by a fibrous endocarp at maturity [30]. If we peel off the hard skin of the mango seed (endocarp), we will find two fleshy pieces, namely mono-embryonic seeds and polyembryonic seeds [31].

MATERIALS AND METHODS

Materials and tools

In this experimental study, the researchers utilized raw materials from mango seeds (*Mangifera indica L.).* the mango seeds originally intact were then processed by chopping the seeds into small pieces so that the resulting color was optimal. Other materials used for the reinforcing, locking, and color-guiding process were made from a solution of lime ($Ca(OH)_2$) and a solution of ferrous sulfate ($FeSO_4.7H_2O$). Apart from the main ingredients, there were also other supplementary ingredients such as alum ($Al_2(SO_4)_3.K_2SO_4.24H_2O$), Turkey Red Oil (TRO), Natrium Carbonate (Na_2CO_3), and starch. Alum and TRO were used to soak the cloth so that the color absorption process got to be optimal, while the Soda ash was used in the process of removing batik wax from the cloth which is known in the context of batik in Java as “lorodan”.

In addition to the natural dye from mango seeds used, in this experiment, researchers also used the medium of "mori prima" type fabric, one type of fabric commonly used for making batik. “Mori prima” is the second subtle mori group after "mori primissima". Prima can be used for the process of making *batik tulis* (writing techniques with canthing tools) and can also be used for *batik cap* (using the stamp technique). Prima fabric is traded in pieces (roll-shaped). This type of fabric comes from Holland and Japan. Prima fabric from Holland with a size per piece is 40 inches wide and 17.5 yards (± 15.5 m) long, while prima fabric from Japan has a size, which is 4.2 inches (± 106 cm) wide and 17.5 yards (± 15.5 m) long. The average fabric arrangement or construction has a total thread per inch for warp 85 – 105 and for feed 70 – 90, while the thread in the English system number Ne_1 for warp is between 36 – 46 and for feed between 38 – 48. Prima fabric contains light starch (under 10%). The prima fabric can be stamped immediately for batik rather rough, while for *batik tulis* (with writing techniques) the *kanji* (cassava flour) in the mori is removed [32]. Mori fabric is a cotton woven fabric with plain woven and yarn density, bleached and without or given starch refinement, used for batik materials, while mori prima fabric is fine mori fabric, made from yarn number Tex 12.3 – Tex 15.5 with weight without starch per square meter 85 grams – 100 grams. The importance of the fabric is highly dependent on the thickness of the fabric and is closely related to the amount of diameter of the warp thread and weft. The tensile strength of the fabric is the strength of the fabric in withstanding the maximum load; an example of a fabric test until the fabric breaks, Tensile Strength Test (kg) of mori fabric warp direction: 19.4, a tensile strength of mori fabric feed direction: 13.3. To determine the resistance of fabric to tearing, mori fabric based on the Tear Strength Test (g) is at least known the warp direction: 680 and the tear strength (g) is at least the feed direction: 680. In detail, the mori fabric material used in this experiment is presented in Table 1.

Tabel 1. Mori fabric test results.

No.	Test Type	Test Method	Test Results
1.	Fabric thickness [mm]	SNI ISO 5084:2010	0.24
2.	Fabric weight [g/m^2]	SNI ISO 3801:2010	111.70
3.	Construction: – Warp density [1/cm] – Weft density [1/cm] – Warp thread number [tex] – Weft thread number [tex] – Face Webbing	SNI ISO 7211-2:2010 SNI ISO 7211-5:2010 SNI ISO 7211-1:2010	42.52 30.91 14.37 13.75 Plain
4.	Fabric composition (%)	SNI 08-0265-89	Cotton 80.23% Rayon 19.77%

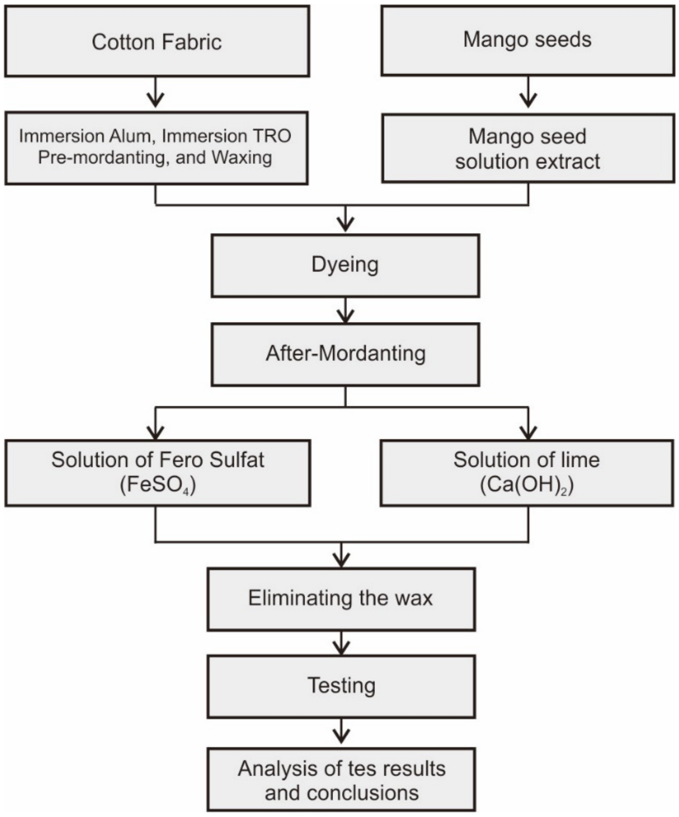

Fig 2. The dyeing process of a batik cloth with a solution of natural dye extract from mango seeds (Mangifera indica L.) [33].

Table 1 describes technical data information on mori fabric material used in experiments with mango seed extract. Mori cloth is a cotton woven fabric with plain woven and tight density, bleached and without or given kanji refinement, used for batik materials.

Mori prima contains light starch (under 10%). The mori can be stamped immediately for batik rather rough, while for *batik tulis* (with writing techniques) the *kanji* (cassava flour) in the mori is removed. The tools used in the process of exploring and developing the dyes were made of mango seed extract which included the tjanting (a pen-like tool) and/or tjanting stamp, pans, electric or gas stoves, scales, measuring cups, dip tubs, pans for extracting natural dyes, "lorodan" tubs, and a tool for testing the color durability through washing and solar exposure.

Research methodology

This study employed an experimental method to explore the natural color of mango seed extraction. Furthermore, the stages of the process and the length of time needed to process mango seed extract are presented in part two in part Preparatory stage. Through this research, it is expected that the existence of mango fruit seeds which were formerly solely a by-product and even as waste got to be utilized as a natural dye for coloring batik clothes. In addition to testing the suitability of mango seeds as a natural dye for batik cloth, this implementation was also carried out as an effort to develop a Teaching Factory-based Batik and Textile Craft Studio.

The process of this natural dye began by selecting the mango seeds, processing the mango seed material, boiling the mango seeds to make their extract, dyeing the fabric/cloth with a solution of mango seed extract, and finalizing it with the fixation process. The material exploration stage was carried out at the Textile and Batik Craft Studio, Visual Arts Education Study Program, Faculty of Art and Design Education, Indonesian University of Education. The findings were then applied to color a batik cloth with the Ubi Cilembu patterns by the researchers teaming up with several batik artisans as well as the owner of the Umy May Batik Studio in Tanjungsari, Sumedang Regency. Furthermore, the result of dyeing the cloth with the Ubi Cilembu patterns with a mango seed extract solution is finally verified. The Seed material of the mango seed extract solution was the dependent variable while the fixator was in the form of lime solution ($Ca(OH)_2$) and Ferrous Sulfate solution ($FeSO_4.7H_2O$) as the independent variables. The cloth that has been dyed and verified was then tested for its Color durability or fastness to washing at 40℃ and Color Fastness to Light: Daylight at the Yogyakarta Center for Crafts and Batik.

Work procedures

The steps taken by the researchers in this study included: a) the processing of the cotton cloth (soaking the cloth with alum or TRO solution); b) the processing of the natural ingredients from mango seeds to obtain the extract solution; c) the process of dyeing the cloth with a mango seed solution extract up to 5 times; d) the color fixation process with a lime solution ($Ca(OH)_2$) as well as a Ferrous Sulfate solution ($FeSO_4.7H_2O$); e) the process of releasing batik wax (pelorodan); e) laboratory testing process; f) the analysis of test results and conclusions. Schematically, the research steps are visualized on the following flowchart in Figure 2.

Preparation stage

In this preparatory stage, there are two main activities comprising the fabric processing and the processing of natural dyes: The first activity, the cloth to be used is firstly soaked using an alum or TRO in order that the absorption of the cloth into the natural dyes from mango seed extract shall be better. The use of alum mordant can be done using two techniques, that is, firstly the so-called 'hot technique' performed by boiling the cloth in an alum mordant solution (alum dose: 50 – 70 g/liter) at 85-90 ºC for 45 minutes, and/or secondly through the cold temperature performed by soaking the cloth for around 10-12 hours.

The second activity is to prepare natural dyes from the mango seeds. At this stage, the researcher prepared the mango seed material in which the mango seeds have to be chopped into smaller pieces. The chopped seeds were then boiled in a ratio: 1:10 (1 kg of ingredients with 10 liters of water). The boiling process for making a solution of mango seed coloring extract is done until the 10 liters of water were reduced to 5 liters only. The process of boiling (solution extraction) of dyes can be done by immersing the material in cold water for 24 hours and heating it up to its boiling state (98°C-100°C). For dyes that are sensitive to heat (eg dyes from flowers), the boiling process can be done around a temperature of 70-80°C [34]. The extract from the mango seeds would next be used for the cloth dyeing process.

Dyeing process

Before the cotton is processed for batik, that is, by writing or applying some hot wax with a writing tjanting or canting stamp, the cotton cloth is preliminarily mordanted with alum solution (6 g/L) by a cold soaking technique for 24 hours. After that, the cotton cloth gets to be rinsed and dried. The cloth that has become a batik is dipped in some water with enough TRO added for a faster and more even wetting process, the cloth is drained until there are no more water droplets, yet the cloth is not supposed to be dried out.

The batik cloth having been prepared is dipped or immersed into the color extract solution from the mango seeds that were brought off in the previous stage. The dyeing process was carried out manually, gradually, and repeatedly as much as needed, with the following stages: a) immerse the batik cloth for 2-4 minutes (as needed), remove the cloth from the dyeing solution and drain the cloth until it is almost dry. The stages of the dyeing process are repeated like those stages. The immersion process in this study was performed up to 5 times with a predetermined duration of immersion (about 2-4 minutes).

Fixation process

The fixation process used in this stage is final mordant fixation. This activity serves to determine the direction as well as to brace the color into the batik cloth so it will not fade out swiftly. In this study, the materials used were a lime fixation solution ($Ca(OH)_2$) with a lime composition of 50 g/L water and a solution of Ferrous Sulfate ($FeSO_4\ 7H_2O$) with a composition of 30 g/L water. This clear fixation solution was obtained after having been deposited for 24 hours. The fixation process in principle is to condition the dye that has been absorbed for a certain time so that an expected reaction will take place between the material being colored with the dye and the material used for fixation. The use of color fixation will affect color fastness or durability. The fixation process aside from strengthening the color and changing the natural dye according to the type of metal that binds it; also gets to brace the dye that has got into the fiber. Materials commonly used for fixation include alum [$K_2SO_4\ Al_2(SO_4)_3\ 24H_2O$], lime ($CaCO_3$), and ferrous sulfate ($FeSO_4$) [35].

Removing wax process

Removing the wax from batik cloth is one important step in the making of batik. The cloth having been written with batik wax and colored with natural dyes is boiled in boiling hot water on a stove at a temperature of 100 ℃. The process of boiling batik cloth uses Natrium Carbonate (Na_2CO_3) (5 g/L) and starch (10 g/L). This auxiliary substance serves to facilitate the removal of wax from batik clothes. After the batik cloth is dyed, it has to be washed using clean water and dried out.

Testing

To find out the accomplishment of the process of coloring a batik cloth with a mango seed extract, some monitoring of the process and results was carried out at the Textile and Batik Craft Studio, Faculty of Art and Design Education, Indonesian University of Education, and at the Umymay Batik Studio. Meanwhile, to determine the color fastness to washing and sunlight, a test was carried out at the Yogyakarta Institute of Batik and Handicraft, Yogyakarta.

Testing results and conclusions

At this stage, the author analyzed and interpreted data elicited from the results of color testing conducted in the laboratory. The type of test employed on this mango seed-dyed batik is related to the dyed batik's color fastness to washing at 40°C and color fastness to sunlight using fixation of lime and ferrous sulfate. The results of the analysis and interpretation were ultimately drawn conclusions upon.

Fig 3. A batik cloth crafted with Ubi Cilembu Patterns.

Fig 4. A natural dye of mango seeds batik patterns with lime fixation.

Fig 5. The results of mango seed-dyed batik with a ferro sulfate fixation.

RESULTS AND DISCUSSION

The results of dyeing Ubi Cilembu – patterned batik with mango seed extract

The process of dyeing the batik cloth with natural dyes of mango seed extract was carried out after the process of writing the cotton cloth with hot wax using a tjanting stamp and or writing canting. The results of the process of stamping or writing batik cloth with hot wax in this study used a tjanting stamp (see Figure 3).

The next process was dyeing the batik cloth with a solution made of mango seed extract. Based on the results of the dyeing, it is known that the color results that appear on the batik cloth with the Cilembu Sweet Potato pattern seemed to result in a different hue. Thus, the same natural dyes, but using a different fixation, will produce different colors (see Figure 4 and Figure 5).

Figure 4 above visualizes the results of dyeing a batik cloth with mango seed extract with a lime fixation solution ($Ca(OH)_2$) prone to produce a cream color towards brown. Meanwhile, Figure 5 visualizes the results of dyeing a batik cloth using a solution of mango seed extract with a solution of ferrous sulfate ($FeSO_4.7H_2O$) fixing agent which brought about a darker color, that is black (Figure 5).

The application of the natural color of the mango seed extract that has been tested is employed in the batik process by batik artisans at the Umymay Studio, Tanjung Sari Sumedang. Figure 6 from left to right shows the activities: the process of stamping batik cloth with a tjanting stamp, dyeing cloth with TRO, the process of dyeing batik cloth, the process of coloring batik cloth, and the pelorodan process. Based on this series of activities, masterworks of batik clothes got to be created (Figure 7).

Figure 7 above is a batik fabric product that uses natural dyes from mango seed extract. The background color of this deep black batik cloth is produced after the batik cloth is dipped five times into the extract of the solution from mango seeds, then dified with ferrous sulfate solution. The color of the Cilembu sweet potato batik motif with red flowers and green leaves uses the synthetic color Remasol with the *colet* technique using kwas. For the next process, this batik fabric can be designed into clothing patterns for both men and women, then sewn into clothes according to the needs of batik lovers consumers.

Fig 6. The immersion process of the batik cloth with the mango seed extract.

Fig 7. A batik cloth dyed with a mango seed extract solution.

Fastness test results to washing and light: daylight

The results of tests performed at the Yogyakarta Arts and Batik Center on a cloth dyed with a mango seed extract solution, the results are presented in Table 2.

The data presented in Table 2 presents a description of the results of the natural color test with mango seed dyes. The batik cloth is made by a means of a stamped batik technique using a tjanting stamp with an Ubi Cilembu pattern. Based on the results of previous studies, the immersion technique of mango seed extract was carried out using a cold technique up to five times. After the batik cloth was dyed, the next step was to fix the batik cloth with a solution of lime ($Ca(OH)_2$) and/or a solution of Ferrous Sulfate ($FeSO_4.7H_2O$).

Batik fabrics fixed with a lime solution and Ferrous Sulfate solution are tested using multifiber upholstery fabric medium: Acetate, Cotton, Polyamide, Polyester, Acrylate, and Wool. This type of test aims to see the stain on each fibre using the Indonesian National Standard (SNI ISO 105-C06:2010). Comparison of color change values (ISO 105-A02) through a type of color fastness test against 40º C washing of fabrics fixed with lime solution ($Ca(OH)_2$) and / or solution of Ferrous Sulfate ($FeSO_4.7H_2O$) It is known the comparison of the results of each with a good category (value 4 on a scale of 5). Next, a comparison of color stain values (ISO 105-A03) against fabrics using lime solution ($Ca(OH)_2$) and / or solution of Ferrous Sulfate ($FeSO_4.7H_2O$) was tested using multifiber coating fabrics known to the results of color stain levels in Acetate, Polyester, Acrylate, and Wool good and very good categories (values 4-5), while the use of cotton upholstery on fabrics fixed with lime solution shows good categories (value 4) and on fabrics fixed with solutions of Ferrous Sulfate categorized as sufficient and very sufficient (values 3-4). Based on these data, information was obtained that the color stain value in acetate, polyamide, polyester, acrylate and wool mediums was better (the natural color of mango seed extract did not move to stain the multifiber coating fabric) than the cotton fibre coating cloth medium with good and very good categories.

In the table above, we also know the information on color fastness to bright sunlight. Based on the type of color fastness test against bright sunlight, it is known that the same ratio in fabrics with fixation of lime solution and Ferrous Sulfate solution with sufficient category values (value 3 on a scale of 5). Batik cloth, so that it is durable and not dull in color, should avoid sunlight.

Fastness test results against washing at 40 °C

This testing process usually makes use of an AATTC WOB soap, which is an optical bleach-free soap used as a standard washing soap in laboratory work on the fastness test of fabric color to washing [36].

The results of the testing respective to the color fastness to washing at 40℃ as presented in Table 1 above were performed using the following testing technique: SNI ISO 105 - C06:2010 (Textile - Test method for color fastness - Part C06: Colorfastness to household and commercial washing); SNI ISO 105-A02:2010 (Textile - Test method for color fastness - Part A02: Grayscale for assessment of discoloration); and SNI ISO 105-A03:2010 (Textile - Test method for color fastness - Part A03: Grayscale for tarnishing assessment). These results shed light that natural dyes from mango seed extract with lime fixation ($Ca(OH)_2$) and/or Ferrous Sulfate solution ($FeSO_4.7H_2O$) are each in a good category (score 4

Table 2 Color Testing Results of Mango Seed Extract.

No.	Test Type	Test Results (Fixator Type)		Test Method
		$Ca(OH)_2$	$FeSO_4.7H_2O$	
1.	Washing Resistance 40 ℃			SNI ISO 105-C06:2010
	Color Change Value	4	4	SNI ISO 105-A02:2010
	Color Blemishes Value			SNI ISO 105-A03:2010
	- Acetate	4 - 5	4 - 5	
	- Cotton	4	3 - 4	
	- Polyamide	4 - 5	4 - 5	
	- Polyester	4 - 5	4 - 5	
	- Acrylate	4 - 5	4 - 5	
	- Wool	4 - 5	4 - 5	
2.	Color Resistance to Light: Day Light Ray			SNI ISO 105-B01:2010
	- Resistant Value	3	3	SNI ISO 105-B02:2010

Description: 1 = bad, 1-2 = bad, 2 = poor, 2-3 = not good, 3 = enough, good enough, 4 = good, 4-5 = good, 5 = very good

on a scale of 5). It means that the color of the clothes made from mango seeds does not dehydrate the color pigment due to dyeing, so the color remains or does not change and does not fade either.

Thus, it is concluded that mango seed extract can be utilized, by the batik artisans, as an alternative dye that is eco-friendly. Based on these data, the use of fixation determines as well as strengthens the colors in the batik cloth. This is in accordance with the opinion that the function of accompaniments apart from increasing the color intensity is also to strengthen the bonds between fibers and colors so as to prevent the dehydration of color pigments [35]. These findings are also advocated by a research report showing that the more/higher the concentration of fixation (mordant) affects the intensity of the resulting color, the higher the concentration of the fixator, the stronger the color will be produced, the function of the fixator is not only to result in forming a color but also to strengthen the bonds between fibers and color so as to prevent dehydration of color pigments [37]. Mordant, meaning "to bite," is a distinct chemical that reacts with dyes in such a way as to bond the dyestuff to the fiber by increasing affinity and/or strengthening the interaction, in certain cases through durable chemical connections, making the color impervious to light and to the washing process [38]. Resting on the author's empirical experience in exploring and experimenting with techniques, natural materials, and fixation materials, and the duration of time in the dyeing process, such activities could affect the results of color intensity on a batik cloth. The color intensity of the batik cloth dyed with natural colors can be adjusted as much as needed. For that being the case, there are several ways that can be done, including a) adjusting the ratio of the number of natural dyes and the boiling water used (the composition is 1 kg of natural ingredients: 10 L of water), the more natural the materials are, the darker/stronger the color intensity will turn up, the smaller the proportion of materials are, the lighter/brighter the intensity will become; b) adjusting the amount of dyeing, the more the amount of dyeing of the batik cloth we use, the darker/stronger the color intensity will appear, while the less the amount of dyeing we use, the lighter/brighter the color intensity will result in; c) immersion time, the longer the dipping duration takes place, the darker/stronger the color intensity will form, while the shorter the dipping time is, the weaker/brighter the color intensity will emerge.

In particular, the color staining value on cotton clothes is closely related to the characteristics of cotton fiber which can bind more dyes than mango seed extract with the fiber to form a bond or have great absorption power after the final mordant processing is completed. The use of organic textile products made from cotton has a higher price but is a form of public awareness about health and the environment [39]. The test results show that there was a slight difference, that is, the batik cloth using fixation lime ($Ca(OH)_2$) was considered in a good category (value 4 on a scale of 5) compared to that using a solution of Ferrous Sulfate ($FeSO_4.7H_2O$) which was in the good enough category (value 3-4 on a scale of 5).

Fastness test results against light: daylight

Color fastness test to light: daylight was performed using testing techniques with SNI ISO 105-B01:2010 (Textiles - Method of color fastness test - Part B01: Colorfastness to light: Daylight) and SNI ISO 105-B02:2010 (Textiles - Test method for color fastness - Part B02: Color fastness to artificial light: Xenon lamp). The results of the color fastness test to light: light, indicate that the results of the dyeing with mango seed extract fixed with lime ($Ca(OH)_2$) and/or Ferrous Sulfate solution ($FeSO_4.7H_2O$) were found to be in the sufficient category (value 3 on the scale 5). In this case, despite employing a different fixation, no significant difference was found. Based on these findings, it is concluded that the use of mango seed extract has a moderate light resistance value, so it is recommended that fabric products that use colors made from mango seed extract should not come into direct contact with sunlight. This is very logical and believed empirically that one that threatens the quality of color is direct sunlight on the batik clothes, the same thing also applies to batik clothes with synthetic dyes.

Built on the results of the data description and analysis above, it is concluded that the natural waste material of mango seeds can be used as an alternative material for good quality natural dyes that are environmentally or eco-friendly. The report by Martuti supports this, et al that clean textile production can protect the environment by applying organic materials as natural dyes. Compared to synthetic variants, this pigment material is considered more biodegradable, relatively safe, and easy to obtain without liquid waste [40]. The discovery of new sources of materials for the textile dyeing process, especially in the batik industry, is also seen as an effort to preserve the textile heritage in Indonesia [41].

The utilization of mango seed waste, formerly a food industry waste that later became an extract for batik dyes, has the value of local wisdom to get to know the biodiversity of the Indonesian nation. This condition is highly expected to improve our attitude in seeing what might appear, at face value, useless as matter of fact, can get to be very useful for the people's prosperity, in this regard, through the discovery of natural organic dye materials. Efforts made to increase the production of natural-colored batik towards sustainable production are significantly influenced by the attitudes and satisfaction of producers, social values, quality values, and green environmental values that produce natural-dyed batik products [11]. Furthermore, to support the use of natural dyes in the Indonesian batik industry, it is necessary to develop instruments containing indicators to assess the sustainability of current batik production with indicators from environmental, economic, and social dimensions [42]. In addition, to address issues related to the environment, there are key factors at the level of goals and objectives which include: a) the role of new ideas about the importance of the environment and an integrated approach to sustainable development promoted by the scientific and research community; b) a group of entrepreneurs promoting these ideas; and c) the institutional structure and working modalities of the Open Working Group (to develop the text of the SDGs) that facilitate the final agreement [43].

The global demand for sustainable, eco-friendly fabrics is challenging to preserve batik as Indonesia's cultural identity [44]**.** For this reason, using natural colors requires understanding and awareness from various stakeholders. Using natural colors to color batik clothes is the right action in reducing environmental pollution today.

CONCLUSION

The utilization of natural materials as a source of developing natural dyes aside from increasing the awareness of environmental sustainability, will also have economically added value in developing a sustainable batik industrial process. Using natural dyes from mango seed extract is an appropriate alternative to reducing environmental pollution problems. For this reason, selecting materials and using the right fixation will produce good colors and be eco-friendly. Based on the testing results related to its fastness to washing and light: daylight, on a batik cloth dyed with mango seed extract showed satisfactory results, thus, natural dyes from mango seeds can be used to develop the current batik industry. Therefore, this study accentuates the need to use natural dyes such as those from the extracted mango seeds. The use of such an eco-friendly material comes as an effort to preserve the value of local wisdom and provide added value to batik artisans.

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