KERSEN LEAF EXTRACT (*Muntingia Calabura L.*) FOR YARN DYEING APPLICATIONS IN LOMBOK-INDONESIAN WEAVING ARTISANS

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ABSTRACT

This study aims to analyze the process of making natural dye extracts from Kersen leaves (Muntingia calabura L.) and the results of dyeing weaving yarn in weaving artisans in Lombok, Indonesia. This natural dye is expected to be an environmentally friendly alternative dye that uniquely enriches local cultural heritage. The cloth that has been dyed with kersen leaf extract is then fixed with three types of fixators, namely: alum solution ($Al_2(SO_4)_3K_2SO_424H_2O$), lime solution ($Ca(OH)_2$), and ferrous sulfate solution ($FeSO_4{\cdot}7H_2O$). The results of the study showed: 1) The technique of making natural dye extracts from kersen leaves carried out by the researcher through the extraction technique of materials with a composition of 200 grams of kersen leaves: 1,000 ml of water into 500 mL of extract solution while what the weavers did was 15 kg of kersen leaves: 30 litres of water into 15 litres of material solution that is ready to be used to dye woven yarn; 2) The use of fixators in addition to directing colors also locks the color on the dyed yarn so that it does not fade easily; the alum solution fixator produces brighter colors; the lime solution fixator produces colors that tend to brown; and the ferrous sulfate ban produces a darker color towards black. This finding recommends the use of kersen leaf extract as an alternative solution for environmentally friendly natural dyes to be used in yarn dyeing in the weaving industry.

KEYWORDS

Experimentation; Kersen Leaf Extract; Yarn Dyeing; Natural Dyes; Lombok Weaving.

INTRODUCTION

One of the most polluting industries in the world is the textile business [1]. The textile industry is one of the sectors that significantly contributes to Indonesia's economy. As one of the country's most important manufacturing sectors, the textile and clothing industry contributed 4.5% of overall foreign exchange exports, with a US $11.6 billion value for Indonesia in 2023 [2].

Behind its large contribution, one problem that threatens the environment arises: the emergence of a large amount of liquid waste from the batik industry process [3]. Dyeing textiles with azo dyes causes wastewater impacts that cause environmental pollution [4]. This increase in textile production and consumption is sometimes not balanced by its focus on optimal waste management [5], [6]. In particular, it is considered important for various relevant stakeholders to appropriately formulate waste management policies to overcome the impact of the textile and sewing industry processes and products as the second most harmful industry to the environment [7].

Dyeing and dyeing textile materials such as yarn in textile production, especially weaving in weavers, often use synthetic dyes. This is done because the type of synthetic dye is seen as more practical, economical, and easy to obtain. However, it seems that it has not been realized that the continuous use of synthetic colors will threaten the environment with toxic waste in the water and soil ecosystem and threaten human health. We know that the use of synthetic dyes in the textile production process, in addition to impacting environmental pollution, also threatens human health [8]. For this reason, it is necessary to find the right solution, which is very important. One of them is using natural dyes from the abundant natural resources of plants around the weavers.

The Kersen plant (*Mutingia calabura L.*) is an antioxidant and antibacterial neotropical tree widespread in Indonesia [9]. As a bioactive compound of the ethyl acetate fraction, Kersen leaf extract contains phenolic components. It has strong

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antioxidant activity [10]. Pharmacologically, the benefits of kersen leaves are known to be a source of bioactive compounds for antidiabetic treatment [11]–[14], anti-inflammatory [15]–[17], antimicrobial [18], anti-acne [19], and antidepressants [20].

In the food industry, such as food, the use of kersen leaves (*Muntingia calabura L.*) as one of the potential sources of nutritional supplements with good antioxidant and anti-inflammatory qualities needs to be promoted for consumption to improve public health [21]. Meanwhile, in the beverage industry, it is also known that kersen leaves can be used for the manufacture of kombucha (a supplement drink from the fermentation process of tea leaves by the symbiotic culture of acid bacteria and yeast), which is safe for daily use [22].

Using kersen leaves in the eco-fashion textile industry has been tried for fabric dyeing materials with the eco print technique through a steaming process using iron, alum, and calcium carbonate fixation. The test results show that the highest level of color brightness appears when using alum fixation agents, while the darkest colors have been produced by iron fixation [23].

Based on several studies described above, previous researchers have conducted studies on kersen leaves according to their scientific fields. Kersen leaves are known to be used as ingredients in traditional medicines but can also be used for food, especially as food and beverage supplements. Kersen leaves in the food sector in the form of eco-fashion to dye fabrics with eco-print techniques that are considered environmentally friendly. However, the author has not found any research that examines the benefits of kersen leaves as a natural dye for woven yarn dyes. To fill the gap, researchers have observed the woven yarn carried out by weaving artisans located in Pringgasela Village, Pringgasela District, East Lombok Regency, Lombok.

The formulation of the research problems proposed in this manuscript is to: 1) Analyze the process of making dye extract materials from natural materials of Kersen leaves (*Muntingia calabura L.*) for the dyeing process of woven yarn through laboratory testing and empirical observations on weaving artisans; 2) Analyze the results of dyeing weaving threads using Kersen leaf extract (*Muntingia calabura L.*) which is fixed with alum solution, lime solution, and ferrous sulfate solution through laboratory testing and empirical observations on weaving artisans. This research is expected to significantly contribute to advancing the weaving industry by using kersen leaves to reduce environmental pollution. The results of this research not only have the potential to provide environmentally friendly solutions for weavers in the weaving industry's production process but can also be a reference for the development of other natural dyes in the future.

Figure 1. Kersen leaves for natural dyes

MATERIALS AND METHODS

Materials

The materials used in this study consist of primary materials, namely natural Kersen leaves (*Muntingia calabura L.*) and cotton weaving yarn measuring about 20-40 Ne (Number English), and secondary materials, namely fixators that function to direct and lock colors.

The natural dye primer used is Kersen leaves (*Muntingia calabura L.*) in Aceh, called "seri," in Java, it is called "seri" or "talok." In the Lombok sasak language, it is called "singgapor." This neotropical type of plant is easy to grow in tropical areas, such as Indonesia. Kersen tree is an evergreen tree with a height of 3–12 meters, constantly evolving and bearing fruit throughout the year. This plant has several names in some countries, such as Jamaican cherry, Panama berry, Singapore cherry in English, and Dutch called Japanese kers [24].

This research also uses cotton yarn material for weaving with the number 20-40 Ne (Number English). This cotton yarn forms woven fabric sheets and describes weaving motifs using a cross technique between warp yarn and weft yarn. In addition to primary materials, the research also uses secondary materials, namely fixators, such as alum solution ($Al_2(SO_4)_3K_2SO_424H_2O$), lime solution ($Ca(OH)_2$), and ferrous sulfate solution ($FeSO_4.7H_2O$), used to determine and bind colors so that they do not fade quickly. In addition to primers and substrates, there are additives such as Turkey Red Oil (TRO) and soda ash (Na_2CO_3) to facilitate the absorption of color in yarn fibers or fabrics during the dyeing process.

Tools

In addition to primary, secondary, and additional materials, this experimental process also uses extraction processing equipment in the form of: 1) steinless steel (not from iron because they affect the extraction results); 2) a stove for boiling kersen leaves; 3) a stopwatch to measure the boiling time of natural dyes; 4) a wooden stirring device; 5) a machete/knife/chopping device to reduce the particles of natural color raw materials so that they form small pieces or chips; 6) Digital PH meter paper, to measure the acidity or alkalinity level of a solvent (natural dyes must be in an acidic/alkaline atmosphere); 7) measuring or liter, in the form of a dipper of a certain size that functions to pour the extract into a bucket where the staining is placed; 8) a sieve, in the form of gauze of a certain size to filter the results of the decoction of kersen leaf extract; 9) fixation equipment in the form of a plastic bucket with a diameter of 40 cm; 10) thermometer to measure the temperature of water at the time of boiling; 11) jars, a place to store kersen leaf color extract before using for yarn dyeing.

Research location

The research location for processing kersen leaves as a natural dye in dyeing weaving yarn was conducted at the Sentosa Pringgasela Weaving Studio at Jalan Rinjani, RW. Sentosa Pringgasela Village, Pringgasela District, East Lombok Regency, West Nusa Tenggara Province and Instrument Chemistry Laboratory at the Universitas Pendidikan Indonesia.

Research methodology

This study used an experimental method to explore the natural color of Kersen leaf extract (*Muntingia calabura L.*). The research variables are the difference in fixators and in the dyeing process of cotton yarn as a weaving material. The natural dye of kersen leaf extract is a dependent variable while the fixator is in the form of alum ($Al_2(SO_4)_3K_2SO_4 \cdot 24H_2O$), lime solution ($Ca(OH)_2$), and ferrous sulfate solutions and solutions ($FeSO_4 \cdot 7H_2O$) as an independent variable.

Working procedure

The stages carried out in this study are: a) soaking cotton yarn using alum and soda ash TRO solution; b) processing of kersen leaves as natural dyes that are sliced into small pieces as needed; c) boiling of kersen leaves into an extract solution; d) the process of dyeing cotton yarn with kersen leaf extract solution 2 3 times; e) the process of fixing the color with alum, lime solution, and ferrous sulfate solution; and e) the process of drying and aerating the yarn by tying and hanging it until it is completely dry, not exposed to direct sunlight. Visually, the experimental stages of making kersen leaf extract for natural dyes of woven yarn are depicted in Figure 2.

Figure 2 shows research activities ranging from preparing and processing woven yarn, processing extract materials from kersen leaves, dyeing yarn, and color fixation. In detail, the working procedures in this study are:

Weaving yarn processing

The yarn is processed by wetting and cooking the woven yarn. The water used for wetting and cooking is healthy (groundwater), with a pH of 6.8.

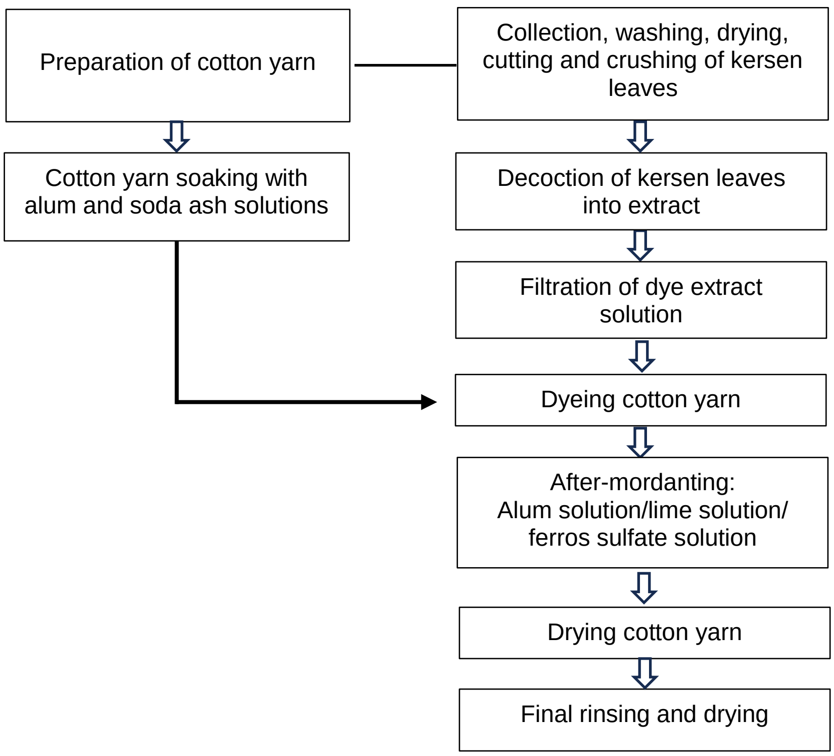


Figure 2. Stages of making dye extract and yarn dyeing process with kersen leaf extract dye.

The thread size used in this experiment is 40 (Ne). In this study, the cotton weaving yarn sample weighed 40 grams with a water volume of 1 L. Furthermore, 60 grams of alum and 13 grams of soda ash (Na_2CO_3) were put in the water. The yarn ripening process is carried out by boiling the yarn in water at a temperature of 95 ºC. The soaking and cooking of woven yarn aims to remove starch so that the absorption of natural dye yarn is optimal. The ratio of soaked yarn to water is 1 : 5 [25]. The cooked woven yarn is then drained to dry for the dyeing process.

Processing process of kersen leaf extract

Natural colors are processed from kersen leaves by extracting techniques by boiling the ingredients for a certain time. The ratio of kersen leaf ingredients, boiling water, and thread weight is: 2 kg 10 liters of water (1 : 5) [25]. The mass of the sample of kersen leaf extract in this study is 200 g with a volume of 1 liter of boiling water. To obtain data and treatment information in this study, kersen leaf extract was made based on the difference in time levels of 30, 45, and 60 minutes. At the same time, the extraction water's pH, the boiling's final temperature, and the extraction volume are also measured, as presented in Table 1 in the findings of the research results.

Yarn dyeing process

The yarn dyeing process was carried out 2 times in a solution of kersen leaf extract with a volume of 400 ml. The dyeing period is 10 minutes each; the dyeing process is repeated after the yarn is dry (not wrung out, not exposed to direct sunlight). The dyed yarn is prepared for the following process: fixing the color of kersen leaf extract on the yarn. The process data and dyeing results are presented in Table 2.

Final fixation process of weaving yarn

The final fixation process of weaving yarn uses the ingredients of alum solution, lime solution, and ferrous sulfate solution. The method of dipping the thread into the fixator solution is carried out once, with each dipping being 5 minutes long. The final fixated thread is then dried and rinsed with clean water. The fixation process directs and locks the color so it does not fade quickly. The three types of fixator materials were applied to three types of woven yarn samples that were classified based on the difference in the boiling time of the extract, namely 30, 45, and 60 minutes. Water pH levels, the length of dyeing time, and pH after the fixation process are also measured at this stage. The treatment results show the difference in yarn color results, as in Table 3 in the research results section.

UV-Vis and FTIR testing of color content from kersen leaf color extract

Testing of color extract samples from kersen leaves using UV-Vis (Ultraviolet-Visible Spectroscopy) spectrophotometry is done to measure light absorption in the ultraviolet spectrum and visible by substances present in water. This test is a spectroscopic analysis technique used to measure the absorbance or transmittance of a sample to light in the ultraviolet (UV, 200–400 nm) and visible (400–700 nm) wavelength ranges by substances present in water. This technique often identifies compounds, determines substance concentrations, and studies a material's optical or electronic characteristics.

FTIR (Fourier Transform Infrared Spectroscopy) is a spectroscopic analysis technique used to identify a compound's functional groups, molecular structure, and chemical interactions based on infrared light absorption. This technique measures how molecules absorb infrared light at a specific wavelength, producing a characteristic spectral pattern. The FTIR spectrum shows peaks specific to each type of chemical bond, allowing for in-depth analysis of the molecular structure and composition of the material.

RESULTS AND DISCUSSION

Research results

Woven yarn processing process

The process of processing woven yarn is carried out through wetting and cooking the woven yarn as described in the work procedure in the method section above to absorb the natural color of the extract from kersen leaves well absorbed by the yarn.

The proces and results of making natural dye extracts from kersen leaves

The process of making natural color extracts from kersen leaf materials carried out by weaving artisans has similarities with the process of making natural dye extracts carried out by batik artisans. However, there are slight differences that the author found through the process of observation and question and answer to the weavers, namely the formulation or comparison of raw materials with water used when making kersen leaf extract. In the context of this study, the ratio of raw materials and water used to boil ingredients is in line with the Indonesian National Work Competency Standards (SKKNI), with a ratio of 1:5 [25]. Meanwhile, the results of observations on weaving artisans obtained information are 1:2. In detail, the results of the process of making natural dye extracts are presented in Table 1.

Table 1 illustrates the comparison of the study sample, which includes sample mass, initial water volume, initial water pH, sample boiling time, water pH after boiling, final boiling temperature, and final volume after boiling. The difference in the length of boiling time from the data affects the pH level of the water after boiling and the final volume after boiling under relatively similar temperature level conditions. The results of the kersen leaf extract are visually presented in Figure 3.

Table 1. Data on the process and results of boiling kersen leaf extract.

No.	Sample Mass [g]	Initial Water Volume [ml]	Initial Water pH	Boiling Time [minutes]	pH of Water after Boiling	Boiling End Temperature [°C]	Final Water Volume after Boiling [ml]
1.	200	1 000	6.4	30	5.5	93	704
2.	200	1 000	6.4	45	5.6	93	650
3.	200	1 000	6.4	60	5.7	93	500

Figure 3. The color of the kersen leaf extract solution based on the length of boiling time.

Table 2. Process and results of fixation of woven yarn dyed with kersen leaf extract.

No.	Name of Fixation Material	Fixator Mass [g]	Initial Water Volume [l]	Initial Water pH	Fixation Dye Length [minutes]	pH Water before Fixation	pH Water after Fixation
1.	Alum	20	1	6.1	5	3.1	3.4
2.	Lime	20	1	6.1	5	14.0	14.0
3.	Ferrous sulfat	20	1	6.1	5	3.0	3.5

Results of dying and fixation woven yarn with kersen leaf extract

In practice, the process and results of dyeing woven yarn between laboratory results and data from the field are different. This condition concerns the pH level of water, kersen leaf material, the length of the extraction boiling process, and the composition of the fixation material. Color fixation on woven yarn uses alum, lime, and ferrous sulfate, lime, and ferrous sulfate solutions. Before the fixation process, the thread is dipped in the fixator solution, and the pH of the fixator solution water is measured. The same thing is also measured after the dyeing process. Based on the results of laboratory tests, information on process data and results of fixation of woven yarn was obtained, as shown in Table 2.

Table 2 informs the process and results of fixation of woven yarn dyed using natural dye extract of kersen leaves. Different pH levels are known. The final pH level of the fixator after use is generally greater (towards the normal direction). The dyeing and color fixation process results on woven yarn with kersen leaf extract show diverse results, as presented in Table 3.

Table 3 shows the data from laboratory research results related to dyed yarn samples associated with the type of fixation material used, boiling time, mass of fixation material, and dyeing time, as well as visualization of the resulting yarn color findings. The yarn dyeing process is done twice, with each sample being carried out for 10 minutes. After the dyeing process, the fixation process of woven yarn samples dyed with kersen leaf extract is carried out with a fixation time of 5 minutes. The data showed that the boiling time of kersen leaf extract affected the level of color intensity produced. The longer the boiling process, the stronger the intensity (dark color).

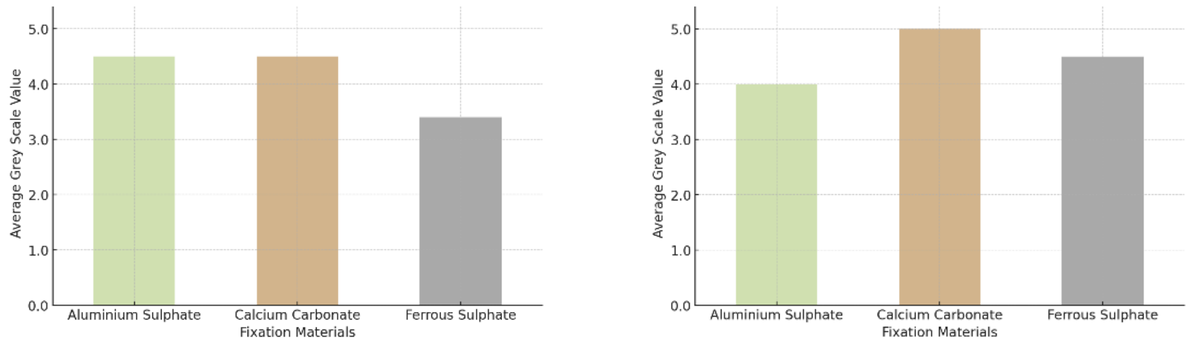
Table 4 shows the analysis of the yarn color fastness test against soap and sunlight washing from yarn samples boiled for 45 minutes, carried out by 7-cycle testing (as in Table 3). The yarn color fastness test analysis results against soap washing are known: yarn fixed with lime and alum has the highest average score of 4.5 (Good). Meanwhile, ferrous sulfate fixed yarns had a lower average value of 3-4 (Fairly Good). The results of the analysis of the results of the yarn color fastness test to sunlight are known: Calcium Carbonate fixated yarn has the highest average score of 5.0 (Very Good), ferrous sulfate fixed yarn is in second position with an average score of 4.5 (Good), and Aluminium Sulphate fixated yarn has the lowest average score of 4.0 (Good).

Table 3. Results of dyeing and fixation of woven yarn from kersen leaf extract.

No.	Sample name	Fixation Materials	Length of Boiling Extract	Fixation Materials	Yarn dyeing time	Yarn Color Results
1.	Kersen leaf extract 1	*Aluminium Sulphate*	30 minutes	50 gr	10 minutes	
			45 minutes	50 gr	10 minutes	
			60 minutes	50 gr	10 minutes	
2.	Kersen leaf extract 2	*Calcium Carbonate*	30 minutes	50 gr	10 minutes	
			45 minutes	50 gr	10 minutes	
			60 minutes	50 gr	10 minutes	
3.	Kersen leaf extract 3	*Ferrous sulfate*	30 minutes	50 gr	10 minutes	
			45 minutes	50 gr	10 minutes	
			60 minutes	50 gr	10 minutes	

Table 4. Color fastness test values with soap and sunlight washing.

Fixation Materials	Test no.	Yarn Color Fastness Test Value Against Soap Washing (Grey Scale)	Test Value of Yarn Color Fastness to Sunlight (Grey Scale)
Aluminium Sulphate	1	4-5 (Good)	4 (Good)
	2	4-5 (Good)	4 (Good)
	3	4-5 (Good)	4 (Good)
	4	4-5 (Good)	4 (Good)
	5	4-5 (Good)	4 (Good)
	6	4-5 (Good)	4 (Good)
	7	4-5 (Good)	4 (Good)
Calcium Carbonate	1	4-5 (Good)	5 (Very Good)
	2	4-5 (Good)	5 (Very Good)
	3	4-5 (Good)	5 (Very Good)
	4	4-5 (Good)	5 (Very Good)
	5	4-5 (Good)	5 (Very Good)
	6	4-5 (Good)	5 (Very Good)
	7	4-5 (Good)	5 (Very Good)
Ferrous Sulphate	1	3-4 (Fairly Good)	4-5 (Good)
	2	3-4 (Fairly Good)	4-5 (Good)
	3	3-4 (Fairly Good)	4-5 (Good)
	4	3-4 (Fairly Good)	4-5 (Good)
	5	3-4 (Fairly Good)	4-5 (Good)
	6	3-4 (Fairly Good)	4-5 (Good)
	7	3-4 (Fairly Good)	4-5 (Good)



(a) (b)

Figure 4. Average yarn color fastness to (a) soap washing, (b) sunlight test value.

Table 5. Results of dyeing kersen leaf color extract on woven yarn.

Yarn Before Dyeing Process	Thread after dyeing by using a fixator		
	Alum Solution ($Al_2(SO_4)_3K_2SO_424H_2O$)	**Lime Solution** ($Ca(OH)$)	**Larutan Ferrous sulfate** ($FeSO_47H_2O$)
			

Visually, Figure 4 and Figure show the yarn color fastness test results to soap and sunlight washing. As a result of washing with soap, samples of yarn fixed with Aluminum Sulfate and Calcium Carbonate had the same result of 4.5, better than yarn fixed with ferrous sulfate. The results of the color fastness test of the yarn against the sunlight exposure resistance of calcium carbonate were fixed at a value of 5, which is the most resistant to sun exposure than the other two samples fixed with ferrous sulfate and aluminum sulfate.

As material for comparison with the data carried out by the researcher, as presented in Table 3 above and in Table 4, the data from field research from weaving artisans in Lombok is presented. The cotton yarn dyeing process for the weaving production process in this study uses natural dyes from kersen leaf extract (Muntingia calabura L.). The yarn dyeing process last 30 minutes to several hours while stirring evenly. To obtain optimal color dyeing results, 3 dyeing processes are carried out.

In the yarn dyeing process, several things must be considered: a) Make sure the yarn has been mordan and TRO; b) Make sure the solution is cool; c) Make sure the thread is evenly dyed in the solution; d) Dry the thread before re-dipping it into the solution; e) The thread should not be squeezed; f) The yarn should not be dried in direct sunlight; and g) The thread is simply aired until the liquid does not drip. The weaving yarn dyeing process can be seen in (see Table 1).

Table 1 above visualizes an example of the results of dyeing woven yarn from natural dyes of kersen leaf extract (*Muntingia calabura* L.) with different fixator materials. Dyeing with an alum solution fixator produces a bright original color; using a lime solution fixator tends to make a color in the direction of brown; and a ferrous sulfate solution fixator produces a color that tends to be blackish-gray. The findings are reinforced by field data related to the practice of dyeing cotton yarn for weaving production that has been carried out by weaving artisans at the research site, as presented in Figure 4 below.

Figure 5 visually shows the yarn dyeing process carried out by weavers in Pringgasela

Figure 5. Activities of weaving craftsmen in the process of dyeing weaving yarn.

Figure 6. Example of Sundawa motif woven fabric dyed with natural ingredients of kersen leaf extract.

Village, Pringgasela District, East Lombok Regency, West Nusa Tengga Province. The two images on the left show dyeing woven yarn using natural ingredients from kersen leaf extract, which is modified with an alum solution to produce a yellowish color. Meanwhile, the two images on the right show dyeing the yarn with kersen leaf extract material fixed with a lime solution, creating a color that tends to brown.

The image on the left of Figure 6 shows the yarn dyed using kersen leaf extract (*Muntingia calabura L.*). Furthermore, by the weaving craftsmen, the yarns that have been dyed through the dyeing process are used to make woven fabrics through the process of crossing the warp yarn and the weft yarn so that it forms the desired motif as shown in the picture on the right.

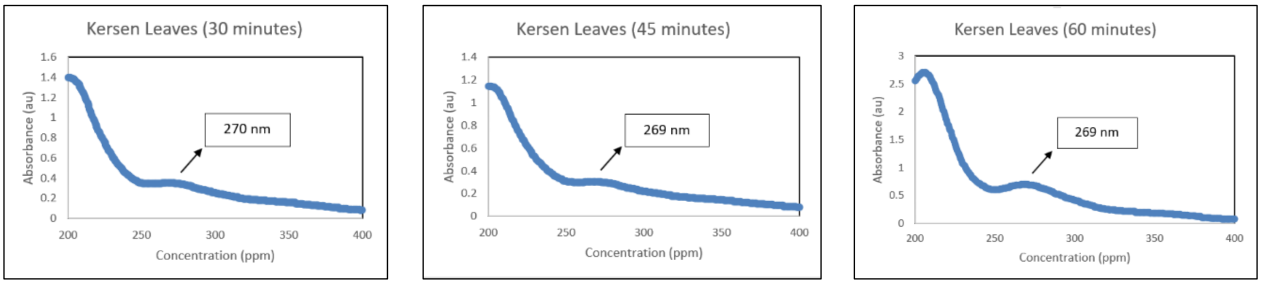
The woven yarn dyed with the natural dye extract of kersen leaves, as described above, is then used by weavers in the weaving production process. The following is an example of a visualization of woven products with Sundawa weaving motifs that use yarn from the dyeing process of kersen leaf extract with different fixators as one of the Sasak weaving motifs in Peringgasela Village, East Lombok Regency, West Nusa Tenggara Province.

UV Vis and FTIR test results

Based on the results of the analysis of the UV-Vis test on the natural dye extract solution of kersen leaves, it is known that the maximum wavelength produced from the three treatment data of kersen leaves with different boiling time durations is 30, 45, and 60 minutes

Figure 7 illustrates the UV absorption data showing that kersen leaf extract was detected at absorption at a maximum wavelength of 270 nm for kersen leaf extract in samples with a boiling time of 30 minutes (Figure 7(a)) and 269 nm for kersen leaf extract at temperatures of 45 (Figure 7(b)) and 60 minutes (Figure 7(c)). The uptake produced from these three data is included in plants' absorption range of flavonoid compounds.

Based on literature searches, flavonoid compounds contained in plants have a maximum wavelength in the range of 200-400 nm [26]. Kersen leaves contain flavonoid compounds, which are medicinal compounds that can be used as antioxidants, antibacterial, and anti-inflammatory. The higher the concentration of kersen leaf extract inhibiting bacteria is in the extract, the higher the concentration of 96% with a methanol solvent [27].



(a) (b) (c)

Figure 7. The maximum wavelength of kersen leaves from boiling the extract was: (a) 30, (b) 45, and (c) 60 minutes.

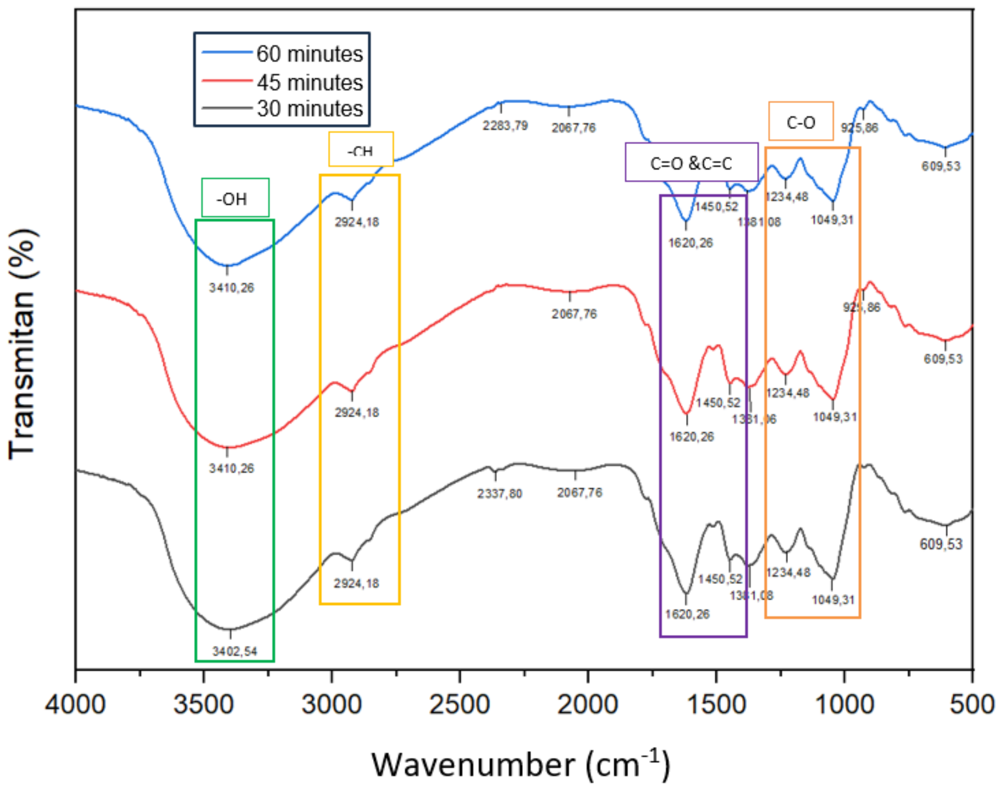


Figure 8. The FTIR spectrum of kersen leaf extract is different based on the boiling time.

The FTIR spectral analysis in Figure 8 above obtained several peaks in various absorption regions, indicating the presence of flavonoids in kersen leaf extract with main/distinctive peaks of (-OH), -CH, C=O, C-O, and C=C aromatic. Spectra analysis showed that there was a wide peak in the absorption area of almost the same wave number for kersen leaf extract in 30-minute, 45-minute, and 60-minute boiling samples, respectively, namely 3402.54 cm^{-1}, 3410.26 cm^{-1}, and 3410.26 cm^{-1}, which were the absorption of -OH *stretching* for the hydroxyl functional group. There is a sharp peak in the absorption area of the same wave number, 2924.18 cm^{-1} in all three spectra. The peak is the absorption of -CH alkyl (-CH sp3). In addition, aromatic C=O and C=C functional groups can be indicated by absorption at the same wave number of 1620.26 cm^{-1} and 1450.52 cm^{-1} in each spectrum at different temperatures. There is a peak at wave number absorption of 1234.48 cm^{-1}, indicating the presence of a C-OH group, and a peak at wave number absorption of 1049.31 cm^{-1}, indicating the presence of C-O-C, including aromatic C-O and aliphatic C-O.

Discussion

The process of making natural dye extracts from kersen leaves is carried out before the cotton yarn dyeing process. In the laboratory research process, researchers process yarn using alum auxiliaries and soda ash (Na_2CO_3) in water. While the yarn is processed by weaving, artisans also process the yarn by soaking cotton yarn using TRO. The purpose of this activity is to make the condition of the yarn clean from starch attached to the yarn so that at the time of dyeing, the color absorption process by the yarn is optimally successful.

The process of making kersen leaf extract that the author has carried out uses 200 g ingredients with a volume of 1 000 ml of boiling water. To determine the difference in the treatment, the researcher determined the boiling time of the kersen leaf color extract for 30, 45, and 60 minutes. After boiling, it is known that the final volume of water after boiling shows a difference (see Table 1). The extracted results are then stored in jars for the following process (Figure 3).

The dyeing yarn stages is carried out according to the need for quality and color intensity. In the context of the laboratory research that the author has conducted, the dyeing of woven yarn was carried out twice on the color extract with a ratio of 1 : 5, which was boiled with a time difference of 30, 45, and 60 minutes (see Table 1). The stages of the dyeing process start from the stage of preparing woven yarn materials in the form of cotton yarn before the dyeing process, the stages of processing kersen leaf materials as natural dyes, the stages of making extracts with a ratio of 1 : 2 (in this study: 15 kg of ingredients and 30 liters of water), continued to the dyeing stage of woven yarn 3 times the dyeing process for maximum results, and the mordanting or color fixation process using alum materials, lime, and ferrous sulfate to direct and bind the color of the yarn so that it does not fade easily (see Figure 2).

The results of dyeing the woven yarn using natural dyes of kersen leaves using alum, lime, and ferous sulfate fixator materials produce different colors. The data in Table 3 above shows the color of the dyeing results of woven yarn as follows: The result of dyeing the yarn with kersen leaf dye extract using an alum solution fixator ($Al_2(SO_4)_3K_2SO_424H_2O$) produces a light and natural color; in the example of the color above, it is more towards light yellow; Results of yarn dyeing with Kersen leaf dye extract using a lime solution fixator ($Ca(OH)_2$) produced a color that tended to lead to brownish, and the result of dyeing the yarn with kersen leaf dye extract using a fixator of ferrous sulfate solution ($FeSO_47H_2O$) produces a yarn color that tends to be darker, namely blackish ash. The same result is reinforced by the data presented in (Table 4 and Figure 4), which informs the dyeing practices carried out by weaving artisans in the yarn dyeing process through dyeing techniques using kersen leaf extract, which is modified with alum solution, lime solution, and ferrous sulfate solution. The same findings were obtained from applying the eco print technique through a steaming process with kersen leaf material. By using iron, alum, and calcium carbonate fixation it is known that the highest level of color brightness appears when using alum fixation agents.

In contrast, the darkest color has been produced by iron/ferrous sulfate fixation [23]. The color of the yarn produced from the laboratory dyeing process (Table 3) is generally similar to the color results carried out by weaving artisans empirically in the field where they produce woven yarn (Table 4 and Figure 4). The findings are reinforced by the results of observations and interviews conducted by the author on weavers, who emphasized that the intensity of the brightness level and color concentration produced from the natural dye material of kersen leaves is greatly influenced by several variables, including the amount of material compared to the water used; the length of time in the dyeing process; and the amount of yarn dyeing done. The more materials used and the longer the dyeing time, and the repetition of dyeing more than three times, the more intense and stronger the color will be. This is in line with research that shows the influence of temperature and dyeing time of cotton yarn [28]. The same findings were obtained from previous research, which stated that the pH level and type of mordant also affect the dyeing results of cotton batik fabrics [29][30].

The yarn color fastness test results against soap and sunlight washing in Table 4 above provide an overview of the quality of yarn color fastness based on the type of fixation used. Testing of three samples of yarn dyed in an extract solution that was boiled for 45 minutes and testing the color fastness of yarn to soap and sun washing as many as seven cycle showed consistent results. Based on these data, the results of the yarn color fastness test against soap washing in the samples of aluminum sulfate and calcium carbonate fixed yarns were better than those of staple fixed yarns (see Figure 4), while the results of the yarn color fastness test with modified iron sulfate were the most resistant to sun exposure compared to the other two samples (see Figure 6). Thus, it can be concluded that the results of the yarn color fastness test against soap washing recommend threads repaired by aluminum sulfate and calcium carbonate. In contrast, the yarn color fastness test results to sunlight recommend using calcium carbonate fixation.

The results of the UV-Vis test on three types of kersen leaf extract solutions, as visualized in Figure 7 above, generally did not find significant differences. In addition, the maximum wavelength absorption of the three data in Figure 6 does not provide a significant difference when looking at the difference in the variation in the length of the extract boiling that has been carried out. The uptake is close to other studies in identifying flavonoid compounds in kumak leaves with the maximum detected wavelengths of 271.2 nm and 272.2 nm [31]. Kersen leaves showed absorption at 269 nm and 259.5 nm wavelengths, which were suspected to be flavonoid compounds [32]. The findings are different from the length of the qualitative test with ethyl acetate extract of kersen leaves using quercetin parent solution, which was analyzed using a UV-Vis spectrophotometer with a maximum wavelength of 438 nm, forming a yellow color indicating that the sample contains flavonoids [33].

Based on the FTIR spectrum presented in Figure 8, the three spectra do not have significant differences; kersen leaves at boiling times of 30, 45, and 60 minutes do not provide much difference when viewed from the change in wavenumber shift in each FTIR spectrum. However, the length of the heating duration shows differences in intensity and peak shape, so heating affects the chemical composition or concentration of certain compounds in the extract. The findings suggest that this spectrum can be used to identify the main functional groups in the extract and how the heating process affects the presence or intensity of certain compounds. Kersen leaf extract has active compounds with functional groups suitable for dyeing batik fabrics that are environmentally friendly, durable, and aesthetically pleasing to be applied to the textile industry, especially batik.

The existence of weaving as a livelihood for weaving artisans needs to be supported by various related parties so that its existence continues to be sustainable. Weaving is one of the potentials that can be developed to grow the economic wheels of the community, which has traditional knowledge and cultural expressions of the nation that need to be protected so that they continue [34]. To support and help traditional weaving SMEs sustainably in terms of social, economic, and environmental performance, it is considered necessary to have a creative and social entrepreneurial orientation in protecting local resources and taking market resources to gain profits [35]. In addition, efforts to improve the quality of weaving processes and products need to be developed with a quality concept to formulate policies for developing this industry as a cultural product built on cultural and economic principles and the mission of weaving products [36]. Thus, traditional weaving is a major income source for weavers and marketers of Ghana's indigenous woven fabrics [37]. The same thing is also found in the role of women weavers in the Batak Toba tribe of North Sumatra in Indonesia; in addition to inheriting and maintaining Ulos weaving as a cultural identity of the community, it also provides an overview of social and economic conditions [38].

The problem of pollution in the dyeing process in the field of weaving in Lombok, Indonesia, has similarities with the dyeing process of materials for the production of mat crafts in the Mekong Delta of Vietnam, namely in the dyeing process of materials that produce waste as a source of environmental pollution [39]. Natural dyes derived from plants in the form of kersen leaves is used in the dyeing of woven yarn with aesthetic, cultural, economic, and environmental considerations. The aesthetic aspect is that the dyeing of woven yarn using kersen leaves produces a distinctive natural, soft, and authentic color on Lombok songket woven fabrics. Cultural aspect: the use of natural dyes of kersen leaves is part of local tradition and wisdom in maintaining cultural identity and traditional heritage in the manufacture of woven fabrics. Economic aspect: natural dyes for kersen leaves are available and easy to get around artisans so that they are not dependent on imported materials, and production costs are reduced. Environmental aspect: natural dyes of kersen leaves are environmentally friendly because they are free from harmful chemical elements and pollute the environment. Kersen leaves are also biodegradable materials, which are materials that are easily decomposed by nature so that they do not cause harmful waste that can pollute the soil or water.

Natural dyes used to process woven yarn for artisans are generally taken from parts of plants consisting of tubers, roots, stems, leaves, and fruit peels [40]. The use of natural colors in the yarn dyeing process has been identified; 13 plant species are used as dyes, and nine species as color binders used by traditional woven fabric artisans in the Pringgasela area, East Lombok, West Nusa Tenggara [41]. Natural dyes from plants are used in Sukarara village, Jonggat District, Central Lombok Regency, West Nusa Tenggara Province. The plant parts include bark, stems, leaves, fruits, seeds, and wood. Eight types of plants produce colors, including red (teak bark and leaves and betel leaves), black (mango leaves), purple (bark and Turi leaves), blue (Tarum leaves and Pace leaves), light green (Pace fruit), dark yellow (Face wood), brown (Acid seeds), and blackish brown (Mahogany bark) [42]. However, the use of natural dye extracts from kersen leaves has not been found. Therefore, natural colors from kersen leaves are expected to add to the richness of natural colors that are environmentally friendly; besides that, it is also believed to be an effort to prevent synthetic dyes that are quite dangerous and cause environmental pollution.

Based on the findings of the research on the use of kersen leaf extract, the author recommends that the government and weavers explore plants, especially kersen leaves, as an effort to take advantage of the potential of abundant natural resources and promote natural wealth in the surrounding area as an effort to strengthen local cultural identity. This is in line with the report of research results in the development of the textile industry, especially in the field of batik, through the process of exploring local plant diversity as a source of ideas to create motives in addition to lifting natural wealth from the environment as well as to strengthen the value of local cultural identity [43]. In addition, using natural dyes also has advantages, including being cheaper, environmentally friendly, and producing distinctive colors [44]. Thus, efforts to use natural colors for the dyeing process of woven yarn are an action for health and add value in terms of economy, empowerment, and intergenerational inheritance efforts [45].

CONCLUSION

The use of kersen leaves as a natural dye in the process of dyeing songket fabric weaving yarn for Lombok weaving artisans. This effort takes advantage of the potential of abundant natural resources in the form of flora around the artisan environment. In addition, using natural dyes for kersen leaves fosters awareness among artisans about reducing or abandoning chemical (synthetic) dyes and switching to natural dyes. Using natural dyes will sustainably create a green and environmentally friendly Lombok weaving industry, save production costs, and increase economic potential and independence.

The selection of natural materials such as kersen leaves to be used as natural color extracts and using fixation materials through the proper process can produce distinctive natural, soft, durable, and environmentally friendly colors. The results of the dyeing experiment of kersen leaf extract on woven yarn produced yarn color intensity with several shades and varying color levels, such as the original bright yellow, brown, and blackish gray. Findings about more varied woven yarn colors with a certain brightness level on types of yarns other than cotton with different fixator materials need further research. Based on the results of the study, it is recommended to use natural dyes such as kersen leaf materials through the extraction and fixation process to preserve the value of local wisdom and added value in Sasak Lombok weaving artisans and weaving artisans in different places.

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