Chi-Square Histogram Analysis of Woven Fabric Images Made from Natural Dyes Due to Exposure to Sunlight

Patrisius Batarius[1] and Alfry A. J. Sinlae[1]
[1]Computer Science Program, Faculty of Engineering, Widya Mandira Catholic University, Kupang, Indonesia
Corresponding author: Patrisius Batarius (e-mail: patrisbatarius@unwira.ac.id).

ABSTRACT This research aims to conduct a Chi-square analysis on the histogram of woven fabric images dyed with natural dyes following exposure to sunlight. Woven fabrics dyed with natural dyes have attracted attention in the textile industry due to their sustainability and environmental safety. Continuous sunlight is a significant factor influencing color changes in woven fabric dyed with natural dyes. The methodology involves capturing images of woven fabric pre- and post-sunlight exposure, followed by histogram analysis using Chi-Square testing, mean, mode, and standard deviation. We utilize pre-cropped and resized grayscale images. Research findings demonstrate that sunlight significantly impacts the histogram of woven fabric images dyed with natural dyes, causing shifts in color distribution, standard deviation, and mode. These findings hold critical implications for the textile industry, particularly for manufacturers of woven fabrics dyed with natural dyes. The application of Chi-Square analysis and standard deviation provides guidelines for product design, maintenance procedures, and consumer education regarding the preservation of color quality in fabrics exposed to sunlight. Changes in the quality of woven fabric images under sunlight exposure can offer essential guidance in the care and maintenance of textile products dyed with natural dyes. This research contributes to a deeper understanding of the interplay between natural dyes, sunlight, and woven fabrics, supporting the development of sun-resistant natural dyes.

KEYWORDS: Chi-Square, natural dyes, sunlight, woven fabric

I. INTRODUCTION

The textile industry has experienced rapid development in recent decades, with various innovations aimed at improving sustainability and environmental safety. One important aspect of this effort is the use of natural dyes in the production of woven fabrics. Natural dyes have become an attractive option due to their more environmentally friendly nature compared to synthetic dyes, which often have a negative impact on the environment and human health [1][2].

However, the use of natural dyes in woven fabrics is not without its challenges. The common view is that there is a decline in the color quality of traditionally woven fabrics made from natural dyes if exposed to sunlight for a long time. One of the factors that affect the color quality of textile products that use natural dyes is sun exposure. Constant sunlight is one of the external factors that can change the color of woven fabrics that have been dyed with natural dyes [2][3]. In everyday environments, textile products exposed to sunlight often experience color changes that can affect the aesthetics and value of the product.

Therefore, it is necessary to understand the impact of sunlight on woven fabrics that use natural dyes. This study aimed to explore color changes in woven fabrics that have been dyed with natural dyes after exposure to sunlight. To achieve this goal, we used Chi-Square analysis, mean, mode, and standard deviation on the histogram of woven fabric imagery before and after exposure to sunlight. This method can provide deeper insight into changes in color distribution in sun-woven fabrics. This study limits the issue to the effect of sun exposure time on the image histogram of woven fabrics using natural dyes.

The results of this study have important implications in the context of the textile industry and the environment [2][4]. We hope that this research can provide a better understanding of the interaction between natural dyes, sunlight, and woven fabrics, as well as lay the foundation for the development of natural dyes that are more resistant to the effects of sunlight. In addition, the results of this study can be a guide for consumers and manufacturers in maintaining the color quality of textile products that use natural dyes when exposed to sunlight. Thus, this research contributes to efforts to make the textile industry more sustainable and environmentally friendly

Some research gaps or gaps that can be the basis for further research include:

1. Effect of Sun Exposure Time: This study focused on the effect of sunlight with various differences in sun exposure time on woven fabrics.
2. Natural Dyes and Types of Woven Fabrics: This study used 2 types of woven fabric images derived from 3 types of natural dyes. The first image with white color, which is made of cornmeal. The second image is a cloth consisting of 3 pieces of white, red and blue colors. The blue color is made from the bauk ulu (local language) and the red color from the bark and roots of noni wood. The process of making color with CRAdips yarn made of cotton into extra water from natural dyes.
3. Development of Sun-Resistant Natural Dyes: These findings could inspire further research in developing natural dyes that are more resistant to the effects of sunlight. This gap invites research to find solutions to maintain color quality in woven fabrics that use natural dyes, especially when exposed to sunlight.
4. Environmental and Sustainability Aspects: Although there is concern for natural dyes due to sustainability and environmental safety, this study does not explicitly explore the impact of sunlight on environmental aspects or sustainability.

II. RELATED RESEARCH

Previous studies on the effect of sunlight on textile products using natural dyes have provided valuable insights into the textile industry, but there are still drawbacks that can be improved. Some previous studies have covered diverse methods, but there is room for further research development. In this review, several previous evaluations examined the impact of sunlight on textile products using natural dyes, as well as identifying flaws in the methods used.

Other research tested the effect of sunlight on the color of woven fabrics using natural dyes with an experimental approach. They hung strips of fabric in the sun over various time intervals and measured changes in image quality at specific intervals using MSE and PSNR parameters [5][6]. The drawback was the absence of in-depth statistical analysis to support their experimental results.

Other research on computer simulations to determine the quality of the process of making natural dyes. The quality of dyeing cotton cloth using jengkol fruit peel waste (Archidendron jiringa) is calculated by calculating K/S and dE values [7]. One of the processes of testing the quality of batik coloring using natural dyes is the color difference test (L*a*b. [8]. Testing of flexing strength, rubbing effect on fabric, and light intensity of Cassia extract plant on wool fabric using CIE L*a.b* [9]. However, the drawback is strong experimental validation, as it relies solely on simulation models. The simulation results may not fully reflect real-world situations. In addition, the study did not provide a deep understanding of color change at a statistically strong level regarding the influence of sunlight on color quality. Although the process of analyzing color changes in textile products uses natural dyes with spectrophotometric methods, the drawback is that it requires expensive equipment and does not consider other external factors that can affect color change.

Another study describes the measurement with the percentage dose of each natural color extract used to show the quality of the color produced [10]. The combination of several extracts of natural dyes can be done to produce good intensity and color elasticity resistance in fabrics [11]. Utilization of bio-mordan almond peel extract as a textile dye, as an alternative that can help reduce dependence on toxic mordan metal. The amount of mordan applied in small quantities (units of g/l) affects the quality of the color used [12]. In addition, using milliliter units per gram (ml / g) as a dose of chemical use [13]. This research is more on the use of microscopy to observe changes at the microscopic level in woven fabric fibers exposed to sunlight. This research focuses more on changes at the fabric cell level. This process does not integrate color analysis of the entire fabric and focuses only on individual cell changes. The results may be less practically relevant in the textile industry.

Another study relates to color resistance tests on woven fabrics that use natural dyes. Assessment of the quality of dyeing woolen fabrics with onion dye using K/S units represented by graphic presentation [14]. The fastness of woolen fabrics with natural dyes such as madder root, chamomile, pomegranate bark, and apple tree bark is excellent. Color strength at K/S=14 [15]. Acceleration testing methods may not fully reflect the color changes that occur in woven fabrics under everyday sunlight conditions.

Although this past research has made important contributions to the understanding of the impact of sunlight on textile products that use natural dyes, there are shortcomings that need to be corrected. Therefore, future research can take a more comprehensive approach by combining various methods, such as field experiments, spectrophotometric analysis, as well as the use of microscopy to understand changes at the microscopic level. This will make it possible to gain a more complete understanding of how sunlight affects textile products that use natural dyes. In addition, the study may also consider different types of woven fabrics and different natural dyes to understand variations in response to sunlight.

Today, image processing has been developed with various methods to analyze image quality in various fields. One of them is in the textile field. Image analysis is carried out by various methods and calculations. Among them are to identify grains based on color feature extraction using RGB and HSV, shape feature extraction using Morphological Threshold, and texture feature extraction using Grey Level Co-occurrence Matrix (GLCM) and Local Binary Pattern (LBP) [16]. Likewise, in the process of classifying plants based on the shape of their leaves with edge detection methods and artificial neural networks [17] or wood fiber classifiers utilizing deep learning [18].

The image processing research above has not discussed the image from the results of statistical analysis. Accuracy in fabric degradation calculations can be predicted from the physical properties of Ultra-Violet degraded woven fabrics at various levels of exposure time [19]. Some of these physical properties can be analyzed through statistical analysis such as chi-square image histogram, mean, standard deviation, and image histogram mode. Chi-square is used for histogram matching in computer vision problems in analyzing facial images and expressions [20]. Research to reduce noise by estimating image noise levels with chi-square distribution [21].

III. RESEARCH CONTRIBUTIONS

This research has various important contributions that can have an impact on various aspects, including the textile industry, science, and the environment. The main contribution of this study is to provide a better understanding of how changes in the image histogram of woven fabrics made from natural dyes occur, over time of sun exposure. These results will provide valuable insights for producers and consumers in managing the treatment of textile products using natural dyes, as well as potentially laying the foundation for the development of natural dyes that are more resistant to the effects of sunlight, support sustainability aspects in the textile industry, and increase understanding of the interaction between natural dyes and sunlight in textile environments.
Some of the key contributions of the study include:

1. A Deeper Understanding of Natural Dyes:
   This research provides a deeper understanding of the influence of sunlight on the color quality of woven fabrics that use natural dyes. This can help textile manufacturers and researchers understand how natural dyes interact with environmental factors, particularly sunlight.
2. Textile Product Care Guide:
   The results of this study can be used as a treatment guide for textile products that use natural dyes. Consumers and manufacturers can utilize this information to maintain the color quality of woven fabrics, reducing the risk of discoloration due to sun exposure.
3. Development of Natural Dyes More Resistant to Sunlight:
   This research could encourage the development of natural dyes that are more resistant to the effects of sunlight. This can contribute to the reduction of the use of synthetic dyes that negatively impact the environment and human health.
4. Sustainability and Environmental Aspects:
   These findings support aspects of sustainability in the textile industry by promoting the use of more environmentally friendly natural dyes. This can be an important step in reducing the textile industry's impact on the environment.
5. Advanced Research:
   This research opens the door to further research that can answer more in-depth questions, such as the effect of sun exposure time, comparisons of different types of natural dyes, and practical applications in the textile industry. This has the potential to provide more comprehensive insights into the understanding of natural dyes and sunlight.

With its contributions covering practical, scientific, and environmental aspects, this research can be the basis for innovation and a better understanding of the use of natural dyes in the textile industry, with a positive impact on the industry and the environment.

IV. RESEARCH METHODS

This research method will prioritize Chi-Square analysis and histograms to understand color changes in textile products that use natural dyes after exposure to sunlight. Figure 1 shows the flow of research conducted.

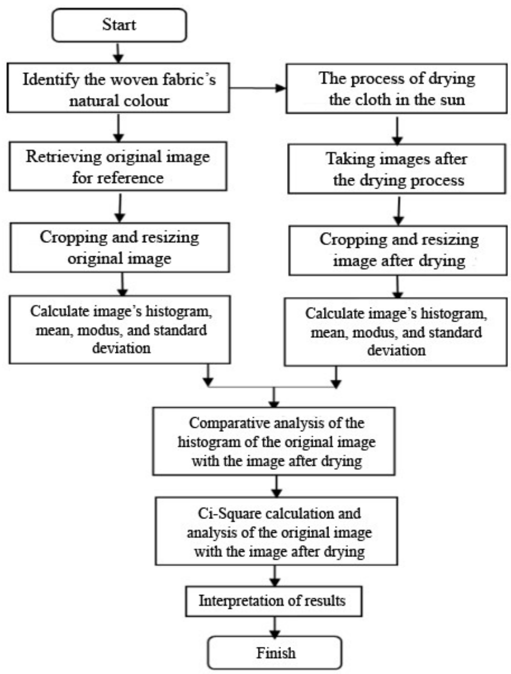


Figure 1. Research process flow

Here are the methodological steps to follow:

1. Identify natural dyes in woven fabrics.
   This stage is the process of collecting image samples of woven fabrics made from natural dyes. The woven fabric used is made of cotton, with natural dyes from corn powder to produce a white color. The red color is made from noni bark, the blue color is made from needle leaves.
2. The stage of taking the original image as a reference. Shooting using a mobile camera with Samsung SM-A315G F2.0 1/50s 4.60mm ISO 125 smartphone specifications with a ratio of 9:16. The shooting distance is 30 cm and the image photo process is one day after drying.

Figure 2 shows the process of taking images before and after drying.

(a) (b) (c)

Figure 2. **The process of capturing woven fabric imagery. Camera distance with woven cloth (a), temperature measurement, room light intensity (b), lighting room conditions when taking images (c).**

The measured light intensity value during the weaving fabric image is 84 x 100 lumens. The average room temperature measured during shooting ranged from 28.30°C to 30.30°C, and the relative humidity was 43%.

3. Drying woven fabrics.
   This stage is to obtain exposure to sunlight with various drying time intervals. The drying time starts at 09.00-15.00, every 1 hour the sun-dried image is taken as in step 2 above. Figure 3 shows the drying process of the fabric and the measurement of the value of light intensity, and temperature during the drying process.

Figure 3. **The drying process of woven fabrics**

TABLE I
DATA ON TEMPERATURE, AIR HUMIDITY, AND LIGHT INTENSITY AT THE TIME OF DRYING WOVEN FABRICS

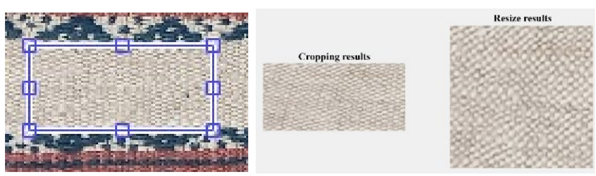
Drying hour	Temperature Value	Relative Humidity	Light Intensity (x 100) Lumen
09:00 - 10:00	$33,1^0$C	42%	1710
10:00 - 11:00	$33,3^0$C	42%	1627
11:00 - 12:00	$33,8^0$C	42%	1649
12:00 - 13:00	$35,8^0$C	42%	1639
13:00 - 14:00	$34,2^0$C	45%	1550
14:00 - 15:00	$34,2^0$C	49%	1546

The value of temperature, the temperature itself, and light intensity at the time of drying woven fabrics are recorded as variables that affect the process of calculating ci-square on woven fabric images.
The data in Table 1 shows the value of temperature, temperature, and light intensity when drying fabrics.

4. The process of cropping and resizing images.
   The cropping stage is carried out to take samples of the analyzed imagery. The process of image resizing to ensure the same image size between the original image and the image after sun exposure.
   The process of cropping and resizing images is carried out using matlab software. Pieces of source code from the cropping and resizing process.

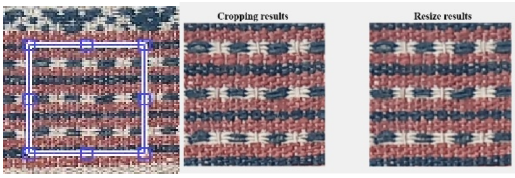
```
% Program cuts image
clc;
clear;
% Read image from file
namafile = 'k1_10-11.jpg';
citra = imread(namafile);
% Display image to view its contents
imshow(citra);
% Create box for crop
kotak = imrect;
%Wait until the box is completed (press Enter)
wait(kotak);
% Get the position and size of the selected box
posisi_kotak = getPosition(kotak);
% Crop the image according to the selected box
citra_crop = imcrop(citra, posisi_kotak);
% Resize image to new size
ukuran_baru = [128, 128];
citra_resize = imresize(citra_crop,
ukuran_baru);

% Displays cropped and resized image
figure;
subplot(1, 2, 1);
imshow(citra_crop);
title('Hasil Crop');
subplot(1, 2, 2);
imshow(citra_resize);
title('Hasil Resize');

% Save the cropped image and resize it to a new
file (optional)
namafile_crop_resize = 'k1_10-
111_resize128.jpg';
imwrite(citra_resize, namafile_crop_resize);
```

The results of the source code of the 'image cropping program', are shown in Figure 4 and Figure 5. Figure 4 is for the image of one type of color, namely white, and Figure 5 is for the image of woven fabric consisting of 3 types of colors. The cropping process that occurs (a) and the selected image crop results (b). Furthermore, the cropped image was resized again with a size of 128x128 pixels (c).



(a) (b) (c)

Figure 4. **The result of cropping and resizing the image of woven fabric for 1 type of color (white color). The cropped part of the woven fabric image (a), the image cropping result (b), and the resizing result (c).**



(a) (b) (c)

Figure 5. The result of cropping and resizing the image of woven fabric (for 3 types of colors). The cropped part of the woven fabric image (a), the image cropping result (b), and the resizing result (c).

The image size used for analysis is 128 x 128 pixels. The process of converting RGB images to grayscale images, with Matlab software. The source code snippet is as follows:

```
% Read RGB image
rgbImage = imread('k1_asli_resize128.jpg');

% Convert RGB to grayscale images manually
grayImage = 0.2989 * rgbImage(:,:,1) + 0.5870
* rgbImage(:,:,2) + 0.1140 * rgbImage(:,:,3);

% Convert image data type to uint8 (0-255)
grayImage = uint8(grayImage);

% Show RGB imagery and grayscale imagery
figure;
subplot(1, 2, 1);
imshow(rgbImage);
title('Citra RGB');
subplot(1, 2, 2);
imshow(grayImage);
title('Citra Grayscale');

% Save grayscale image
nama_citra_gray =
'k1_asli_resize128_gray.jpg';
imwrite(grayImage, nama_citra_gray);
disp(['The grayscale image has been saved as:
', nama_citra_gray]);
```

The results of the source code above are shown in Figure 6

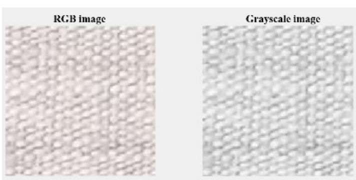


Figure 6. RGB image display and gray scale image

5. Calculation and analysis of the histogram
   The original image and the image exposed to the heat of sunlight are calculated histogram values. The calculation results analyzed several parameters such as the mean, mode, and standard deviation of each image. Image types in histogram analysis use grayscale images.
6. Calculation and analysis of ci-square original imagery with imagery after exposure to sunlight.
   Chi-square analysis is performed by calculating the per-pixel ratio between the original image and each image after sun exposure. Chi-square calculations use grayscale image types.
7. Interpretation of results.
   This stage is the process of interpreting the results of the Chi-Square analysis to determine whether the change in the histogram image of woven fabrics exposed to sunlight is significant or not. Compare results between different types of woven fabrics and natural dyes to identify differences in response to sunlight.
8. Conclusions and implications
   Summarize findings and conclusions from Chi-Square analysis and histogram. Discuss the implications of these research results in the context of the textile industry, sustainability, and the development of natural dyes that are more resistant to sunlight.

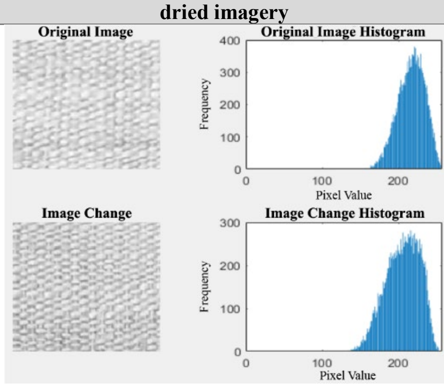
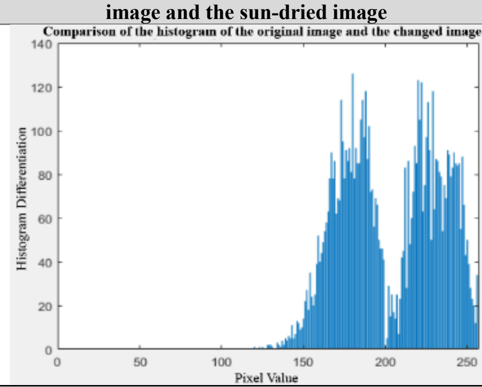
V. RESULT

The results of this study provide valuable insight into the impact of sunlight on textile products that use natural dyes. The following is a description of the results of this study:

A. WHITE COLOR

Tables 2 and 3 show the results of changes in the histogram of the original image and the image after drying. Each sun-dried image is compared to the original image. The type of image is grayscale.

TABLE II
CHANGES IN THE HISTOGRAM OF THE ORIGINAL IMAGE WITH THE IMAGE AFTER EXPOSURE TO SUNLIGHT. AS WELL AS THE DIFFERENCE IN THE HISTOGRAM OF THE TWO IMAGES

Drying hour	Histogram display of original imagery and sun-dried imagery	The difference between the histogram of the original image and the sun-dried image
09.00-10.00		

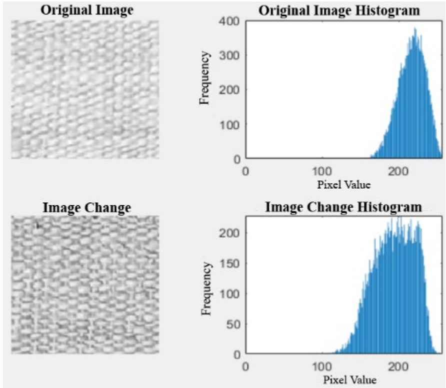
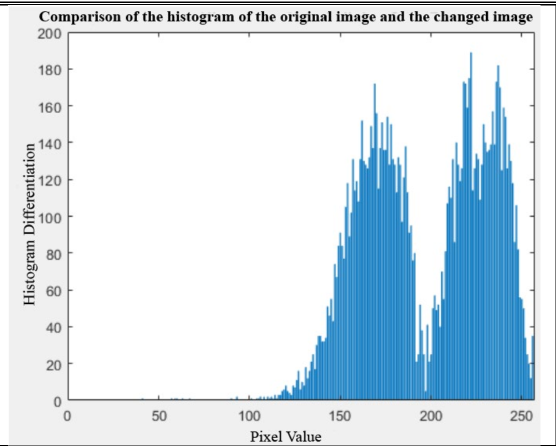
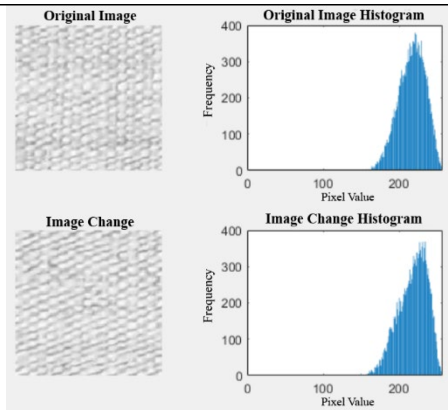
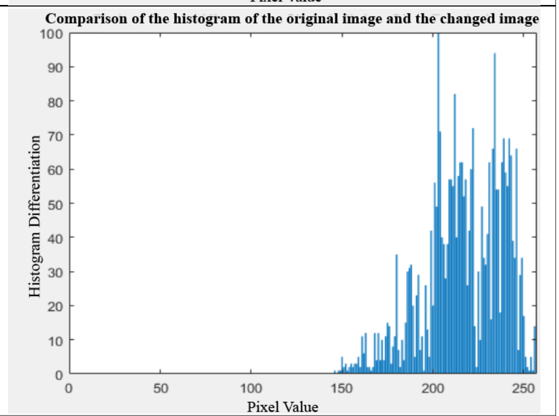
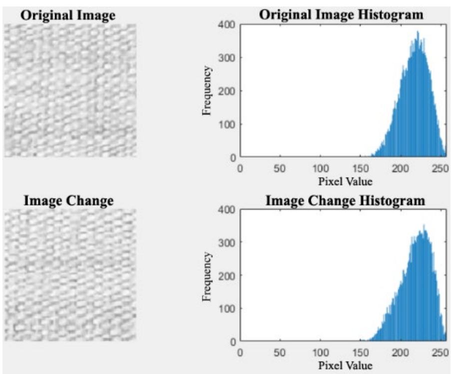
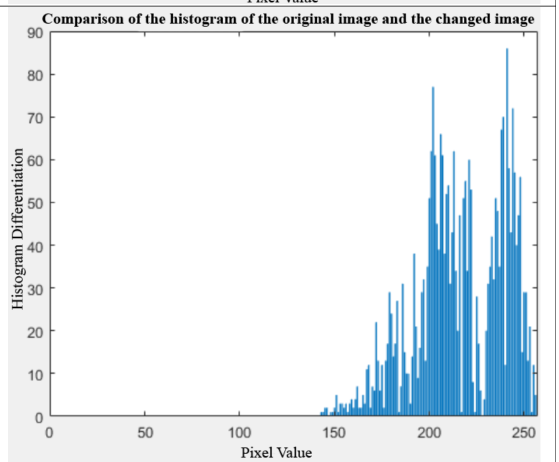
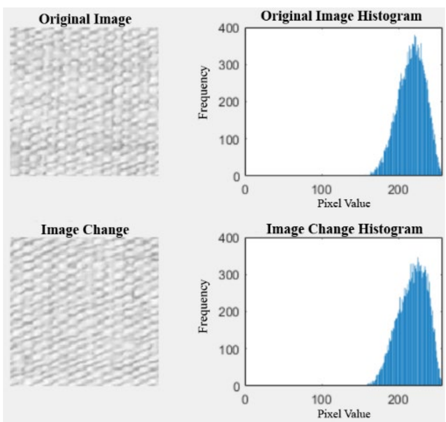
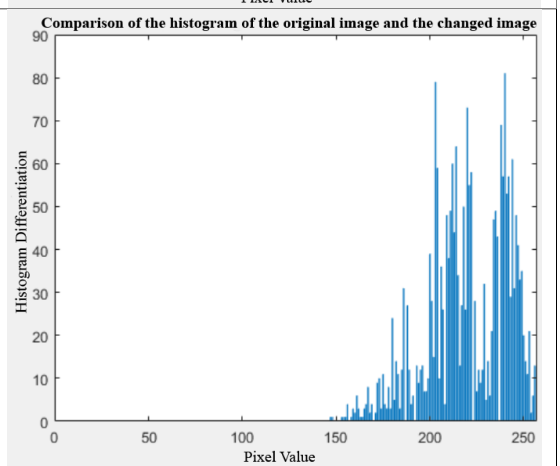
10.00-11.00		
11.00-12.00		
12.00-13.00		
13.00-14.00		

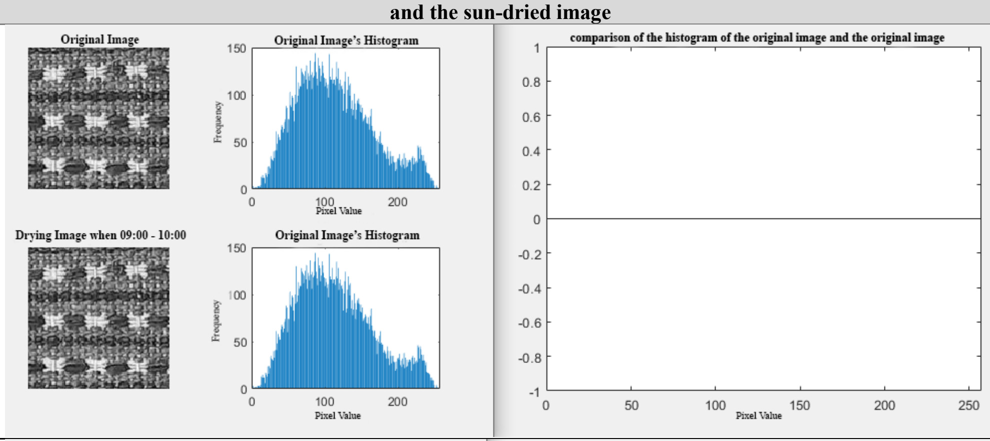
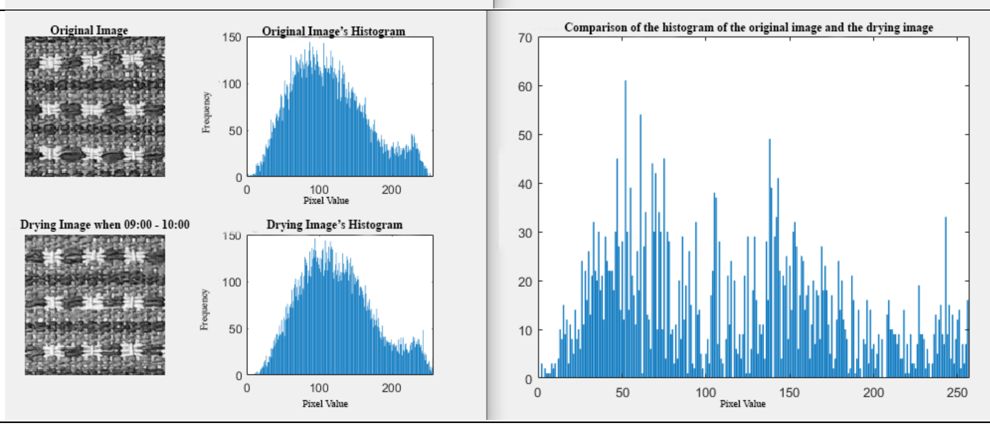
TABLE III
CHI-SQUARE VALUE, MEAN, MODE, AND STANDARD DEVIATION OF THE ORIGINAL IMAGE WITH THE IMAGE AFTER DRYING IN SUNLIGHT

Drying hour	mean	Standard deviation	Mode	Chi-Square value of original imagery with image after drying
Original image	64	11,51	220	-
09.00-10.00	64	95,49	215	2752,2413
10.00-11.00	64	83,23	198	7160,2007
11.00-12.00	64	108,34	233	389,4071
12.00-13.00	64	107,25	228	373,4448
13.00-14.00	64	107,17	224	254,0882

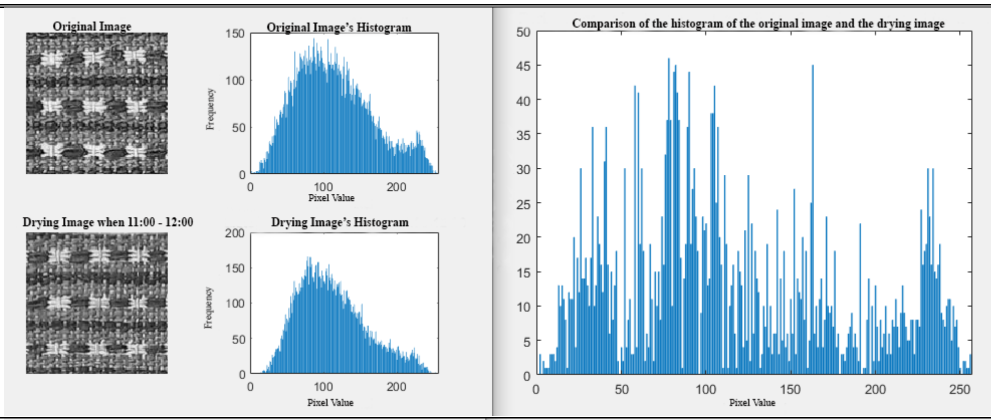
B. IMAGE WITH 3 COLOR TYPES

Tables 4 and 5 show the histogram results of the original image with the image exposed to sunlight. Table 4 shows histogram values such as mean, standard deviation mode of histogram image, and chi-square value between the original image and sunlight image.

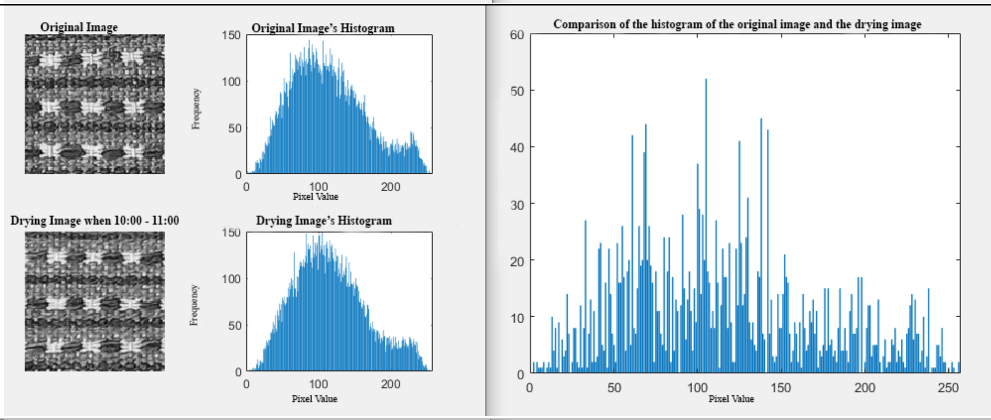
TABLE IV
CHANGES IN THE HISTOGRAM OF THE ORIGINAL IMAGE WITH THE IMAGE AFTER EXPOSURE TO SUNLIGHT, AS WELL AS THE DIFFERENCE IN THE HISTOGRAM OF THE TWO IMAGES FOR IMAGES WITH 3 TYPES OF COLORS

<table>
<tr><th>Drying hour</th><th>Display of the original image, the changed image and the histogram difference between the original image and the sun-dried image</th></tr>
<tr><td>Original image</td><td>
</td></tr>
<tr><td>09.00-10.00</td><td>
</td></tr>
</table>

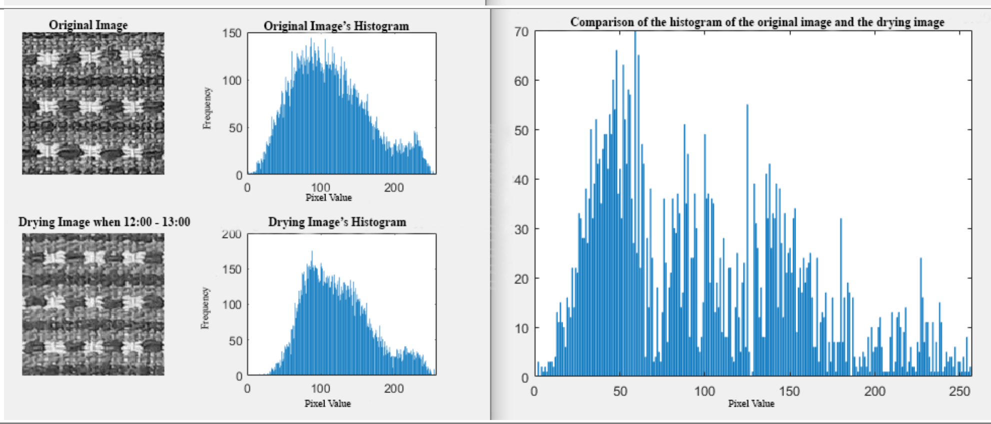
11.00-12.00



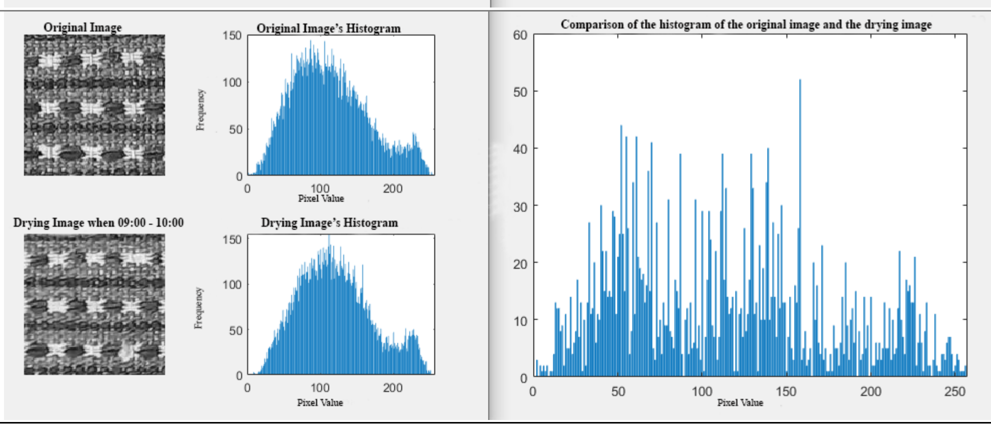
10.00-11.00



12.00-13.00



13.00-14.00



14.00-15.00

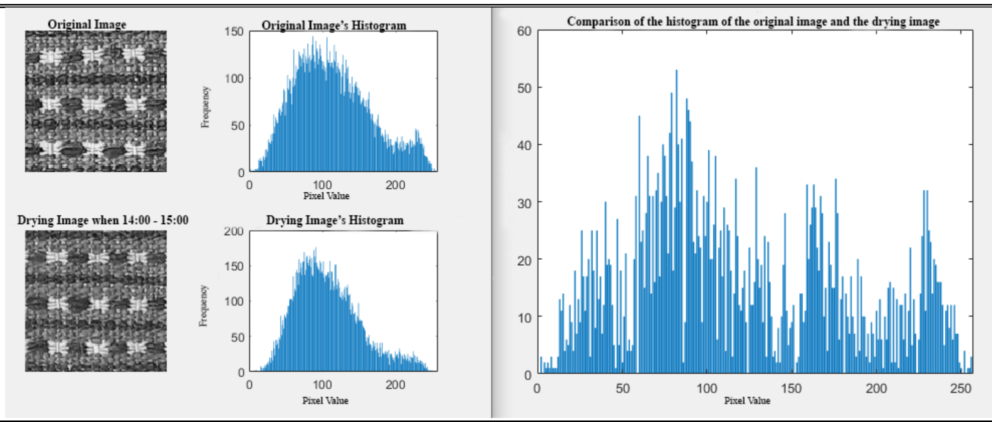


TABLE V

CHI-SQUARE, MEAN, MODE, AND STANDARD DEVIATION VALUES OF THE ORIGINAL IMAGE WITH THE IMAGE AFTER DRYING IN SUNLIGHT FOR IMAGES WITH 3 COLOR TYPES

Drying hour	mean	Standard deviation	Mode	Chi-Square value of original imagery with image after drying
Original image	64	41,69	86	729,5334
09.00-10.00	64	42,76	93	671,2343
10.00-11.00	64	44,26	104	322,1226
11.00-12.00	64	50,54	77	1509,5554
12.00-13.00	64	52,41	87	475,6603
13.00-14.00	64	43,23	111	821,6233
14.00-15.00	64	54,84	90	729,5334

The results of Chi-Square, standard deviation, mean and histogram mode of image tests show that changes in image histogram are statistically significant. This confirms that sunlight has a noticeable impact on the color distribution of woven fabric products that use natural dyes.

1. Standard deviation
   Standard deviations tend to rise and fall over time, indicating changes in pixel intensity variations in the image. The highest standard deviation occurred at 1 p.m., indicating the highest variation in pixel intensity at the time, while the lowest standard deviation occurred at 9 a.m. This data provides insight into how imagery intensity fluctuates during the day and may be related to changes in lighting or other factors affecting imagery during those hours. A higher standard deviation indicates a greater difference in the pixel intensity distribution of the image at a given hour
   The first image (white), drying from 11 a.m.—12:00 p.m. or 1:00 p.m. has a high standard deviation value. The difference in value from the 3rd drying time is small. The lowest standard deviation value at drying time is 09.00-10.00. While the 2nd image of drying at 14.00-15.00 has the highest and lowest values at 0900-10.00.
2. Mode Value
   This mode data can be useful for understanding how the most common pixel intensities are in an image. This value indicates a change in the nature of the image. Mode values that change over time in a drying session indicate changes in image properties. This change is the result of changes in lighting conditions during drying time. Changes in mode values reflect the difference in pixel intensity distribution between images taken each hour.
   The first image of the largest mode value during drying time is at 11:00-12:00 and lowest at 10:00-11:00. The second largest mode value in woven fabric image with a drying time of 13.00-14.00 and the lowest drying time of cloth is 11.00-12.00.
3. The chi-square value of imagery
   The Chi-Square Histogram value of the image shows a useful parameter for understanding the extent to which woven fabric images differ in terms of their pixel intensity over a period of drying time. This Chi-Square Histogram reflects the difference in pixel intensity distribution during the hours of drying. The higher the Chi-Square value, the greater the difference in the pixel intensity distribution between the original image and the sun-dried image.
   The greatest chi-square value at drying time is 10:00-11:00 for the first image 13:00-14:00 and 10:00-11:00 for the second cloth image. While the lowest value is at 14.00-15.00 for the first image at 11.00-12.00 for the second image.
   Two times compared.

The results of this study provide valuable insights into an effort to maintain the color quality of textile products that use natural dyes under sun exposure conditions. With a deeper understanding of color change and color distribution at a statistical level, the textile industry can continue to move towards sustainability, reduce environmental impact, and deliver better products to consumers.

VI. DISCUSSION

The discussion of the results of this study opens up space for a deeper understanding of the impact of sunlight on textile products that use natural dyes. Changes in the image histogram show a significant change in the image of woven fabrics made from natural dyes due to exposure to sunlight. These changes reflect shifts in color distribution that can affect the visual appearance of textile products. This is in accordance with the common observation that textile products exposed to sunlight often experience color changes.

Changes in the statistical value of woven fabric imagery caused by sunlight can vary between drying intervals and times and the type of natural dye used in woven fabrics made of cotton. Chi-Square test results, mode, and standard deviation are significant, this study provides statistical validation of the color changes observed in the histogram. This confirms that the color change is not the result of chance, but a significant effect of sun exposure.

The response to sunlight can vary between the types of natural dyes used. This is a very important finding, as it suggests that some textile products may be more resistant to the effects of sunlight than others. This can provide an opportunity for manufacturers to choose natural dyes or woven fabrics that are more suitable for specific applications.

The results of this study have practical implications for producers and consumers in the textile industry. Manufacturers can use this knowledge to develop products that are more resistant to sun-induced discoloration or provide better care guidance to consumers. Consumers, on the other hand, can use this information to maintain the quality of textile products they have under conditions of sun exposure.

This research supports aspects of sustainability in the textile industry. With a better understanding of the impact of sunlight on textile products that use natural dyes, manufacturers can reduce resource wastage, reduce the risk of unwanted discoloration, and increase efficiency in product care. The results of this study can be the foundation for the development of natural dyes that are more resistant to sunlight. This is a positive step in reducing the use of synthetic dyes that negatively impact the environment and human health, as well as creating more sustainable alternatives.

However, it's important to remember that this study still has some limitations. One is to focus on sun exposure as the only external factor affecting textile products. In real-world situations, textile products may be exposed to a variety of external factors, such as changing weather, humidity, and air pollution. Therefore, further research may consider the interaction between sunlight and these factors.

VII. CONCLUSION

This study illustrates the impact of sunlight on textile products, especially woven fabrics made from natural dyes. This impact focuses on the emphasis of the image histogram and the analysis of the Chi-Square, mode, and standard deviation of the image histogram. The contribution made to this research slightly contributed to the understanding of the textile industry, especially woven fabrics made from natural dyes. The statistical value gained in the discussion, helps manufacturers to create products that are more resistant to the effects of sunlight and supports sustainability efforts in this industry. Further research can expand the results of this study by considering other external factors and supporting the development of natural dyes that are more resistant to sunlight.

This research has not received accuracy from textile experts. This research is one way to determine the image quality of woven fabrics made from natural dyes. Further development is needed between the results of this research and the process in the textile world.

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AUTHORS CONTRIBUTION

Patrisius Batarius: Contributed to chi-square analysis and statistical analysis of histogram images.
Alfry Aristo Jansen Sinlae: Image data capture before and after sun exposure.

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