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Fabric Type Effects on Color Fastness and Color Difference of *Artocarpus elasticus* Ecoprint

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ABSTRACT

This study investigated the effect of fabric type on color fastness to soaping and color differences in ecoprint fabrics produced using jomok bark (*Artocarpus elasticus*). An experimental method with a one-factor Completely Randomized Design (CRD) was employed, using satin, silk, and mori primissima fabrics. Ecoprinting was performed using the steaming technique with alum as the mordant. Colorfastness to soaping was tested according to SNI ISO 105-C06:2010, while color differences were evaluated according to SNI ISO 105-J03:2015 using a spectrophotometer to measure L*, a*, b*, and dE*ab values. Data were analyzed using the Kruskal– Wallis test, analysis of variance (ANOVA), and appropriate post hoc tests. The results showed that fabric type significantly affected colorfastness to soaping ($p = 0.01832$). Satin achieved the highest mean score (4.5), while silk and mori primissima each scored 4.0; all fabrics were classified as good. Fabric type did not significantly affect lightness (L*) ($p = 0.112$), but significantly affected a* ($p = 0.0019$), b* ($p = 0.0007$), and dE*ab ($p = 0.00002$). The highest mean lightness (L*) value was observed in mori primissima fabric at 76.38. The highest mean a*, b*, and dE*ab values were observed in silk fabric at 10.47, 33.08, and 46.62, respectively.These findings demonstrate that fabric type influences the colorfastness and color characteristics of jomok bark ecoprint fabrics. Fabric selection should therefore consider the desired color characteristics and colorfastness requirements of the final textile product.

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INTRODUCTION

Clothing is one of the basic human necessities, and the rapid evolution of fashion trends has driven continuous growth in the textile industry. Increasing demand for diverse designs, patterns dan colors has encouraged textile manufacturers to expand clothing production and develop increasingly intensive dyeing processes. This growth has contributed significantly to the global textile industry's economic value, which is currently estimated at USD 610.91 billion and is projected to reach USD 755.38 bilion by 2027 [1]. However the expansion of the textile industry has also raised serious environmental concerns, particularly due to the generation of large quantities of wastewater and dye-containing sludge. China as the world's largest textile-producing country, accounted for approximately 20% of global textile production in 2020 and generated approximately 1.84 billion tons of industrial

wastewater, including around 2.3 million tons of hazardous textile dye sludge with a moisture content of approximately 60% [2].

Synthetic dyes used in textile processing are a major source of water pollution because their residues can persist in aquatic environments and may pose carcinogenic and genotoxic risks. Exposure to these pollutants can adversely affect industrial workers and aquatic organisms, potentially causing chromosomal abnormalities, physiological alterations, and disturbances in spermatogenesis [3]. The severe pollution and environmental damage caused by waste from the use of synthetic dyes have led the textile industry to begin using natural dyes [4]. The global community is also beginning to shift toward using plants and their waste as environmentally friendly dyes [5]. Plants, minerals, and animals are sources of natural dyes that are naturally biodegradable and non-toxic [6]. Natural dyes are becoming increasingly popular due to consumers' health-conscious mindsets, leading them to choose environmentally friendly and sustainable textile products [7]. Indonesia has various natural dyeing techniques, one of the current trends being ecoprint. The ecoprint technique is a textile design method that involves printing shapes and pigments from plant parts onto fabric surfaces using natural dyes [8]. The application of ecoprint is considered more environmentally friendly and sustainable because it can minimize the use of chemicals and water in the textile dyeing process [9]. This is supported by ecoprint-based Micro, Small and Medium-sized Enterprises (MSMEs) in Yogyakarta and Central Java that have implemented green supply chain management, indicating that greater innovation leads to improved sustainable company performance [10]. Ecoprint exploration can be developed using various plants that grow in Indonesia. The jomok plant (*Artocarpus elasticus*) is an abundant natural resource that grows widely in Bengkulu, Papua, Kalimantan, and West Java. *Artocarpus elasticus* has been cultivated by the people of Bengkulu for handicraft souvenirs, while the Dayak people use it to make clothing for traditional ceremonies [11]. *Artocarpus elasticus* is rich in prenylated flavonoids, which have significant cytotoxic effects against human cancer cells [12]. Based on test results, flavonoid dyes applied to linen fabric produce attractive and soft colors and provide benefits for skin health [13]. The bark of the jomok tree (*Artocarpus elasticus*) does not easily die even when it is harvested for use, in fact new bark can grow back [14]. *Artocarpus elasticus* has great potential for use as a natural dye. However to date, the bark of *Artocarpus elasticus* has not been fully utilized in ecoprint production. To determine the dyeing results of *Artocarpus elasticus* bark using the ecoprint technique, treatments will be carried out using different types of fabric.

Previous studies have examined natural dyes derived from tree bark and several factors that influence colour fastness and colour characteristics in textile dyeing processes. Silva et al. [15] investigated the potential of *Croton urucurana* bark extract as a natural dye and evaluated its colour fastness to light, washing, rubbing, and perspiration. However, their study focused on bark extraction as a dye rather than on motif formation through the ecoprinting technique. Sekarini et al. [16] investigated the effects of extraction volume and fixation conditions on colour characteristics and colour fastness in batik fabrics using natural dye derived from jackfruit bark (*Artocarpus heterophylla Lamk.*). Their study used a dyeing method involving jackfruit bark extraction and a dyeing approach that differed from the ecoprinting of jomok bark (*Artocarpus elasticus*). Other studies on ecoprinting have also explored the effects of fabric type, steaming duration, mordant type, and natural dye type on the resulting colours and motifs [17]. However, these studies evaluated colour expression and motif clarity qualitatively and did not report tests of colour fastness to soaping or comprehensive instrumental measurements of the L*, a*, b*, and dE*ab parameters to compare different fabric types. In addition, another ecoprinting study evaluated motif aesthetics, colour characteristics, and colour fastness to soaping and wet rubbing in silk ecoprint fabrics using various types of leaves, mordants, and natural dyes [18]. That study focused on silk fabrics and variations in leaf types, mordants, and natural dyes rather than on comparing different fabric types using jomok bark as a colour source. Based on the

reviewed literature, studies specifically evaluating the effects of fabric type on colour fastness to soaping and instrumental colour characteristics in jomok bark (*Artocarpus elasticus*) ecoprinting remain limited. To address this research gap, this study compares satin, silk, and mori primissima fabrics processed using the steaming technique and alum fixation under the same treatment conditions. The specific contribution of this study is to provide direct comparative evidence of the effects of three fabric types on colour fastness to soaping and colour differences based on the instrumental parameters L, a*, b*, and dE*ab in ecoprinting using motifs derived from jomok bark (*Artocarpus elasticus*).

METHOD

This study employed an experimental method to determine the effect of fabric type on the colorfastness and color difference of ecoprint fabrics produced using jomok tree bark (*Artocarpus elasticus*). The selection of fabric types in ecoprint research needs to consider fiber characteristics and the fabric's ability to absorb natural color pigments from plants [19]. Ecoprinting is generally applied to fabrics made from natural fibers because they can absorb color pigments from plants. This is consistent with another study stating that fabrics derived from natural materials can absorb plant pigments effectively [20]. Based on these considerations, this study used three types of fabric: satin, silk, and mori primissima. These three fabric types were selected to compare the quality of the ecoprint results because they have different fabric characteristics. The characteristics of each fabric type are presented in Table1.

Table 1. Characteristics of Fabric Types

Jenis kain	Characteristics
Satin	Made from a blend of polyester and cellulosic fibers, with a relatively smooth and lustrous surface
Silk	Made from natural protein fibers, with a smooth, lustrous, and soft surface
Mori primissima	Made from natural cellulosic fibers, with a relatively smooth surface

The differences in the material and surface characteristics of the three fabric types provided the basis for investigating colorfastness to soaping and the color difference of ecoprint fabrics produced using Artocarpus elasticus. Color difference was evaluated based on the instrumental parameters L*, a*, b*, and dE*ab.

The study employed a Completely Randomized Design (CRD) with one factor, namely fabric type consisting of three treatment levels: satin, silk, and mori primissima. Each fabric type underwent an ecoprinting treatment using jomok tree bark (*Artocarpus elasticus*) through the steaming technique, with alum used as the fixative, while other treatment conditions were controlled. The quality of the resulting ecoprint fabrics was then evaluated in accordance with SNI ISO 105-C06:2010 for colorfastness to soaping and SNI ISO 105-J03:2015 for color difference measurement. The experimental data were analyzed using appropriate statistical methods to determine the effect of fabric type on the quality of the ecoprint results.

Preparation of Jomok Tree Bark

The preparation of jomok tree bark (*Artocarpus elasticus*) was carried out through a peeling process. The first step involved removing the outermost bark using a peeling knife. Next, the trunk was struck with moderate force to facilitate the peeling process and prevent the bark from tearing. The final step involved peeling off the inner bark, which was then used as a natural material to create motifs on the fabric during the ecoprinting process.

Fabric Preparation and Mordanting Process

This study used three types of fabric: satin, silk, and mori primissima. The fabrics underwent the mordanting process directly without prior washing. For mori primissima fabric, the mordanting process used a liquor ratio of 1:30, with a fabric weight of 200 g. The mordanting solution consisted of TRO at a concentration of 2 g/L, alum at 20 g/L, and soda ash at 5 g/L. The solution was heated to 100°C. The fabric was immersed in the solution and stirred for 1 hour. After heating was completed, the fabric was left immersed for 24 hours at room temperature. Subsequently, the fabric was rinsed without wringing and dried using an iron. For satin and silk fabrics, the mordanting process used a liquor ratio of 1:40, with a fabric weight of 200 g. The mordanting solution consisted of TRO at a concentration of 2 g/L and alum at 20 g/L. The solution was heated to 60°C. The fabrics were immersed in the solution and stirred for 1 hour. After heating was completed, the fabrics were left immersed for 24 hours at room temperature. Subsequently, the fabrics were rinsed without wringing and dried using an iron.

Ecoprinting Process Using the Steaming Technique and Alum Fixation

The ecoprinting process was carried out using the steaming technique. The fabrics that had undergone the mordanting process were spread out on a flat surface. Pieces of jomok tree bark were then arranged on the fabric according to the desired motif. The fabric was folded lengthwise to cover the bark, then folded again into a smaller section and pressed. Next, the fabric was tightly rolled in plastic and tied with sewing thread.

The fabric roll was steamed for 30 minutes during the first steaming stage. After the first steaming stage was completed, the fabric roll was removed and immersed for 3 minutes in an alum solution at a concentration of 50 g/L. The fabric roll was then steamed again for 30 minutes.

After the second steaming stage was completed, the fabric roll was removed, the ties were undone, and the fabric was unfolded. Any remaining jomok tree bark adhering to the fabric was then removed. The fabric was rinsed with clean water and air-dried.

Testing Colorfastness to Washing

The colorfastness-to-washing test was conducted in accordance with SNI ISO 105-C06:2010. The test specimens measured 10 × 4 cm. A soap solution was prepared at a concentration of 5 g/L using distilled water. The specimens were then treated in the soap solution at 40–50 °C for 30 minutes. After the test, the specimens were rinsed twice with cold distilled water, followed by rinsing under running cold water for 10 minutes. The color change in each specimen was assessed using a grey scale, and the results were recorded as colorfastness ratings.

Color Difference Measurement

Color difference was measured using a UV-PC spectrophotometer on fabric specimens measuring 5 × 5 cm. The measurements provided three color coordinates: L*, a*, and b*. The total color difference (dE*ab) was calculated by comparing the color coordinates of the ecoprinted fabrics with those of the untreated reference fabrics. In the CIELAB color system, L represents lightness, a* indicates the red–green axis, and b* represents the yellow–blue axis.

RESULTS AND DISCUSSION

Results

This study employed an experimental research design to investigate the effect of fabric type on the quality of ecoprint results using jomok bark (*Artocarpus elasticus*), in terms of colorfastness to soaping and color difference. Colorfastness was evaluated using a Grey Scale, while color differences

were measured using a spectrophotometer. The ecoprinting technique employed in this study was the steaming technique. The laboratory test results for colorfastness to soaping of the textile fabrics are presented in Table 2.

Table 2. Results of the Colorfastness to Soaping Test

Test		A1 (Satin)	A2 (Silk)	A3 (Mori primissima)
Colorfastness to Soaping	1	4,5	4	4
	2	4,5	4	4
	3	4,5	4	4

The descriptive analysis conducted using RStudio showed that the average colorfastness ratings of the ecoprint results were 4.5 for satin, 4.0 for silk, and 4.0 for mori primissima. The colorfastness test results for all three fabric types were classified as good. During the soaping process, the evaluation of color changes in the test specimens using the Grey Scale under a light box revealed that the color changes were barely perceptible.

The Kruskal–Wallis test results for colorfastness to soaping showed a chi-squared value of 8, with 2 degrees of freedom (df) and a p-value of 0.01832, which was less than 0.05. These results indicate a statistically significant difference in colorfastness to soaping among satin, silk, and mori primissima fabrics. This finding suggests that fabric type influences the quality of ecoprint produced using jomok bark (*Artocarpus elasticus*).

To further investigate the effect of fabric type on colorfastness to soaping, a post hoc Mann–Whitney test was conducted using the Wilcoxon rank-sum test. The results of the pairwise Wilcoxon rank-sum test with Bonferroni correction in RStudio showed that the comparisons between satin and silk, as well as between satin and mori primissima, yielded p-values of 0.094, which were greater than 0.05. Therefore, neither pair showed a statistically significant difference in colorfastness to soaping.

The laboratory test results for color difference in the textile fabrics are presented in Tables 2–5.

Table 3. Lightness Value (L*)

Ecoprinting Technique	Test	A1 (Satin)	A2 (Silk)	A3 (Mori primissima)
Steam	1	75,17	69,71	73,3
	2	68,61	69,71	76,73
	3	75,7	62,42	79,11
Mean		73,16	67,28	76,38

The lightness value (L*) indicates the brightness of the resulting color, with a higher mean L* value representing a lighter color. Under the steaming technique, mori primissima fabric exhibited the highest mean L* value of 76.38.

Table 4. Red–Green Color Coordinate (a*)

Ecoprinting Technique	Test	A1 (Satin)	A2 (Silk)	A3 (Kain mori primissima)
Steam	1	2,43	9,08	11
	2	3,47	11,91	6,85
	3	2,92	10,43	8,54
Mean		2,94	10,47	8,79

The red–green color coordinate (a*) indicates the position of a color along the red–green axis. Positive a* values indicate a tendency toward red, whereas negative values indicate a tendency toward green. Under the steaming technique, silk fabric exhibited the highest mean a* value of 10.47, indicating a stronger reddish color tendency.

Table 5. Blue–Yellow Color Coordinate (b*)

Ecoprinting Technique	Test	A1 (Satin)	A2 (Silk)	A3 (Mori primissima)
Steam	1	16,24	31,79	31,88
	2	19,45	34,49	26,2
	3	17,93	32,97	25,06
Mean		17,87	33,08	27,71

The blue–yellow color coordinate (b*) indicates the position of a color along the blue–yellow axis. Positive b* values indicate a tendency toward yellow, whereas negative values indicate a tendency toward blue. Under the steaming technique, silk fabric exhibited the highest mean b* value of 33.08, indicating a stronger yellowish color tendency.

Table 6. Total Color Difference (dE*ab)

Ecoprinting Technique	Test	A1 (Satin)	A2 (Silk)	A3 (Mori primissima)
Steam	1	30,98	43,69	12,61
	2	37,34	46,34	7,84
	3	29,63	49,83	8,68
Rata - rata		32,65	46,62	9,71

The highest mean value of the total light reflection measured under illumination (dE*ab) will produce the darkest color. The highest dE*ab value in the color difference test results will produce the brightest color. The highest dE*ab value was found in silk fabric, with a mean value of 46.62.

Statistical calculations using RStudio showed that the normality test results for L* had a p-value of 0.01074 < 0.05, indicating that the data were not normally distributed. The a* value had a p-value of 0.9085 > 0.05, indicating that the data were normally distributed. The b* value had a p-value of 0.5315 > 0.05, indicating that the data were normally distributed. The dE*ab value had a p-value of 0.1530 > 0.05, indicating that the data were normally distributed. Based on the results of the homogeneity test using Levene's test, L had a p-value of 0.9813 > 0.05, a* had a p-value of 1.0385, b* had a p-value of 0.4790 > 0.05, and dE*ab had a p-value of 0.1149 > 0.05. Thus, the assumption of homogeneity of variances among fabric types showed no significant deviation based on Levene's test.

To determine the effect of fabric type on ecoprint quality in terms of color difference, the results of the Kruskal–Wallis test were examined. The results showed that the lightness value (L*) had a chi-squared value of 4.3922, df = 2, and a p-value of 0.112 > 0.05, indicating that there was no significant difference in lightness (L*) among the different fabric types. The results of the follow-up Wilcoxon test with Bonferroni correction also showed no significant differences between any pairs of fabric types. Satin and silk fabrics had a p-value of 1.00 > 0.05, satin and mori primissima fabrics had a p-value of 1.00 > 0.05, and silk and mori primissima fabrics had a p-value of 0.23 > 0.05.

The ANOVA results for a*, b*, and dE*ab showed that fabric type had a significant effect on the ecoprint results. The a value had a p-value of 0.0019 < 0.05, the b* value had a p-value of 0.0007 < 0.05, and the dE*ab value had a p-value of 0.00002 < 0.05. To further determine the effect of fabric type on color difference, Tukey's test was performed. The results of the Tukey post hoc test for a showed significant differences between satin and silk fabrics (p = 0.00196) and between satin and mori primissima fabrics (p = 0.00699). However, there was no significant difference between silk and mori primissima fabrics (p = 0.40704). The results of the Tukey post hoc test for b* showed significant differences between satin and silk fabrics (p = 0.00063) and between satin and mori primissima fabrics (p = 0.00615). However, there was no significant difference between silk and mori primissima fabrics (p = 0.0788). The results of the Tukey post hoc test for dE*ab showed significant differences among all pairs of fabric types, namely satin and silk fabrics (p = 0.0050), satin and mori primissima fabrics (p =

0.00036), and silk and mori primissima fabrics (p = 0.000023). These findings indicate that fabric type significantly affected the total color difference of the jomok bark (*Artocarpus elasticus*) ecoprint results.

Discussion

Good ecoprint quality is indicated by the results of colorfastness testing. This study showed that the colorfastness to soaping of ecoprints produced using jomok tree bark was classified as good. Satin fabric had a mean score of 4.5, whereas silk and mori primissima fabrics each had a mean score of 4. These results indicate that all three fabric types exhibited good colorfastness. The Kruskal–Wallis test revealed an overall statistically significant difference among the three fabric types (p = 0.018). This finding is consistent with the study by Yasukawa et al. [21], which showed that silk fabric produced a deeper color than cotton fabric when dyed using Fuji apple peel extract. That study also reported relatively low colorfastness to washing, particularly in terms of color change, which could be improved through the use of Ti^{4+} and Fe^{3+} mordants. These findings suggest that fiber characteristics and mordant application may be associated with the results of natural dyeing, although greater color depth does not necessarily indicate better colorfastness. A study by Kamal et al. [22] on natural dyes extracted from water apple (*Syzygium samarangense*) leaves also demonstrated differences in washing colorfastness between cotton and silk fabrics. Cotton fabric has been reported to achieve colorfastness scores of 3–4, whereas silk has shown scores ranging from 4–5 to 5. These findings suggest that the response to natural dyes may differ depending on the type of fiber. In the present study, satin achieved the highest mean colorfastness score (4.5), while both silk and mori primissima received a mean score of 4. Although the mean scores differed, post hoc testing with Bonferroni correction found no statistically significant differences between satin and silk or between satin and mori primissima. Thus, the higher mean score for satin does not provide sufficient evidence to conclude that it has significantly better colorfastness than the other fabrics. Ningtarich et al. [23] investigated ecoprinting with Cosmos sulphureus and several other flower species on cotton, linen, and silk fabrics. Their results showed soaping colorfastness scores of 4–5, classified as good. This finding is comparable to the results of the present study, in which all three fabrics also demonstrated good colorfastness. However, the results should be compared with care because the studies used different dye sources, fabric types, and processing conditions.

The present study adds to existing research by examining the washing colorfastness of ecoprinted fabrics treated with jomok tree bark. All three fabrics achieved good ratings, although their mean scores were not identical. These variations may be related to differences in fiber composition, surface characteristics, and the interaction between the fabric and the color-producing compounds. The fabrics examined in this study satin, silk, and mori primissima differ in their fiber composition. Cellulose-based fabrics are commonly used for natural dyeing [24], while silk is composed of natural protein fibers and mori primissima consists of natural cellulose fibers. The satin fabric used in this study contains a blend of cellulose and synthetic fibers. These differences provide a basis for considering how the properties of each material may relate to colorfastness in the ecoprint process. This finding is consistent with previous research indicating that natural fibers, particularly those derived from plants and animals, are generally suitable for use as ecoprinting media because their characteristics can support the absorption of natural dyes and interactions between the dyes and fabric fibers [25].

Effect of Fabric Type on Color Lightness (L*)

Mori primissima had the highest mean L* value (76.38), followed by satin (73.16) and silk (67.28). Based on these mean values, the color on mori primissima appeared lighter, while silk showed the lowest lightness. A similar pattern was reported by Kamal et al. [22], who found higher L* values for cotton than for silk dyed with *Syzygium samarangense* leaf extract. The L* values ranged from

72.613 to 81.059 for cotton and from 58.203 to 66.839 for silk. These findings are consistent with the descriptive trend observed in the present study, although the dye sources and processing conditions differed.

Lightness in naturally dyed fabrics may also vary with the mordanting process. Baek et al. [26], in their study of cotton and silk dyed with phycocyanin extracted from blue-green algae, reported that L* values depended on the mordant and the method of mordant application. Before mordanting, the L* values of cotton and silk were 87.2 and 87.1, respectively, showing almost no difference in lightness at that stage. Similarly, Scarano et al. [27] observed differences in the L* values of linen, cotton, and wool dyed with *Rhus coriaria L.*, with linen exhibiting greater lightness than the other two fabrics under the conditions examined. Taken together, these studies suggest that the lightness of naturally dyed textiles may be associated with several factors, including fiber composition, fabric characteristics, dye source, and mordanting treatment.

In the present study, mori primissima showed the highest mean L* value among the three fabrics. However, the Kruskal–Wallis test did not reveal a statistically significant difference in L* values between satin, silk, and mori primissima ($p = 0.112$). The differences in mean values should therefore be interpreted as descriptive patterns rather than evidence of a statistically significant effect of fabric type on lightness. Further investigation with a larger sample size or different processing conditions may help clarify whether these observed differences are reproducible.

Effect of Fabric Type on the Red–Green Color Coordinate (a*)

Silk fabric exhibited the highest mean a* value (10.47), followed by mori primissima (8.80) and satin (2.94). These results suggest that the ecoprint color on silk had a stronger tendency toward red than that on satin. The ANOVA results showed a significant effect of fabric type on a* values ($p = 0.0019$). Tukey's post hoc test identified significant differences between satin and silk and between satin and mori primissima. However, the difference between silk and mori primissima was not statistically significant. This indicates that, although the three fabrics showed different mean a* values, the differences between silk and mori primissima were not sufficiently large to be statistically significant under the conditions of this study.

The observed differences may be related to how the color-producing compounds in jomok bark interact with each fabric during the ecoprint process. *Artocarpus elasticus* contains flavonoid compounds that have potential as natural colorants. Depending on their molecular structure, some flavonoid compounds can produce orange hues [28]. In addition to the properties of the colorant, the use of a fixative may also influence the resulting color. Alum, for example, has been reported to produce brighter colors in natural dyeing [29]. These factors may help explain the variation in a* values among the fabrics examined. However, since this study did not identify the individual pigments responsible for the resulting colors, the role of specific flavonoid compounds in the observed red-coordinate differences requires further investigation. In the present study, *Artocarpus elasticus* produced several different colors, as shown in Figure 1.



Figure 1. Ecoprint Results Using Jomok Bark (*Artocarpus elasticus*)

Effect of Fabric Type on the Blue–Yellow Color Coordinate (b*)

Silk fabric recorded the highest mean b* value (33.08), followed by mori primissima (27.71) and satin (17.87). The b* values were positive for all three fabrics, showing that the resulting ecoprint colors had a yellowish tendency. ANOVA confirmed a significant effect of fabric type on b* values ($p = 0.0007$). According to Tukey's post hoc test, significant differences were found between satin and silk and between satin and mori primissima. However, the difference between silk and mori primissima was not statistically significant at the 5% level. This pattern suggests that the yellow color coordinate varied with fabric type, although the extent of the difference was not the same for every fabric pair. Such variation may be related to differences in the interaction between the pigments released from jomok bark and the fabric materials during steaming.

Similar variations in b* values have been reported in previous studies. Muruganandham et al. [30], for example, found b* values of 75.35 for cotton and 62.85 for silk when *Bixa orellana* seed extract was applied using an ultrasonic water bath. Under direct heating, however, silk showed a higher b* value (59.35) than cotton (51.64). These findings suggest that the relationship between fabric type and the yellow color coordinate may change with the dyeing method. Ostheim et al. [31] likewise reported differences in the b* values of wool, cotton, and Lyocell depending on the dyes and mordants used. Geelani et al. [32] also observed differences in the uptake of natural dyes extracted from Juglans regia leaves across fabric types, with cotton showing a lower affinity for the dyes than protein-based fabrics under their experimental conditions. Taken together, these studies suggest that the yellow color coordinate of naturally dyed textiles is influenced by several factors, including fiber composition, dye source, dyeing technique, and mordant treatment. In the present study, the higher b* value of silk compared with satin indicates a stronger yellow tendency under the conditions used, while the difference between silk and mori primissima was not statistically significant. Therefore, the results should be interpreted in the context of the specific fabrics and steaming process examined in this study.

Effect of Fabric Type on Total Color Difference (dE*ab)

Silk fabric showed the highest mean dE*ab value (46.62), while satin and mori primissima fabrics had mean values of 32.65 and 9.71, respectively. The one-way ANOVA indicated a significant effect of fabric type on dE*ab values ($p = 0.00002$). This result was further supported by Tukey's post hoc test, which identified significant differences between each pair of fabrics: satin and silk ($p = 0.005$), satin and mori primissima ($p = 0.00036$), and silk and mori primissima ($p = 0.000023$). These results demonstrate that the magnitude of the total color difference relative to the measurement reference varied significantly among the three fabrics. The highest value was observed in silk, whereas mori primissima had the lowest. However, these differences describe the extent of color change relative to the reference and should not be interpreted as a direct measure of dyeing quality.

However, dE*ab values should not be interpreted as a direct measure of color lightness or color quality. Lightness is represented by L*, whereas dE*ab describes the magnitude of the overall color difference. Therefore, although silk fabric had the highest dE*ab value, this does not mean that silk produced the lightest color. Based on the L* values, mori primissima fabric actually had the highest mean lightness. The total color difference, dE*ab, was used to evaluate the magnitude of the color difference between the jomok tree bark (*Artocarpus elasticus*) ecoprinted fabric and the reference fabric before treatment. In this study, silk fabric had a mean dE*ab value of 46.62, whereas satin fabric had a mean value of 32.65. These results can be discussed in relation to the study by Scarano et al. [33], who evaluated natural dyes extracted from *Opuntia ficus-indica* fruit peel on cotton and wool fibers using undyed fabrics as references. Their study showed that color difference values varied according to fiber type and mordant treatment. When alum was used, the reported dE*ab values were 64.95 for cotton and 48.42 for wool. Meanwhile, Karadag [34] investigated the dyeing of cotton fabrics using natural

pigments from *Datisca cannabina*, *Quercus ithaburensis*, and *Punica granatum* fruit peel. Spectrophotometric measurements using the CIELAB system showed low color variation among measurements taken from the same fabric, supporting the importance of instrumental measurements for evaluating the color characteristics and uniformity of naturally dyed textiles.

These two studies demonstrate that instrumental color evaluation can be used to investigate the results of natural dyeing, although the focus of the measurements needs to be considered. The study by Scarano et al. is relevant to discussing color differences associated with fiber type and mordant use, whereas the study by Karadag supports the evaluation of color uniformity in dyed fabrics. Therefore, the dE*ab values in the present study indicate the magnitude of the color difference between the ecoprinted fabrics and the reference fabric. Although the mean dE*ab value of silk was higher than that of satin, this result does not, in itself, indicate that silk has better dyeing performance. Interpretation should consider material characteristics, dye sources, color application methods, and the measurement references used in each study.

CONCLUSION

Fabric type had a statistically significant effect on colorfastness to soaping and certain color characteristics of ecoprinted fabrics produced using jomok tree bark (*Artocarpus elasticus*). The mean colorfastness score of satin fabric was 4.5, whereas silk and mori primissima fabrics each obtained a score of 4, which were classified as good. Although the Kruskal–Wallis test indicated an overall statistically significant difference ($p = 0.018$), pairwise comparisons with Bonferroni correction showed no statistically significant differences between satin and silk or between satin and mori primissima ($p = 0.094$). Regarding color characteristics, fabric type did not produce a statistically significant difference in lightness (L*) ($p = 0.112$), but it had a statistically significant effect on the red–green color coordinate (a*), the yellow–blue color coordinate (b*), and the total color difference (dE*ab). The mean dE*ab values of silk, satin, and mori primissima fabrics were 46.62, 32.65, and 9.71, respectively.

The findings suggest that the choice of fabric for ecoprinting with jomok tree bark needs to be considered in relation to the characteristics of the material and the intended use of the textile product. The differences in dE*ab values show that each fabric exhibited a different degree of color difference compared with the reference fabric. Nevertheless, a higher dE*ab value should not be interpreted as an indication of better dyeing quality, since this parameter only measures the magnitude of color difference. Fabric selection should therefore be based on the desired color characteristics, colorfastness, and properties of the material, taking into account the intended application of the final product. Several limitations should be considered when interpreting these results. This study examined only three fabric types and used an alum solution with a concentration of 50 g/L, together with the steaming technique and jomok tree bark (*Artocarpus elasticus*). The findings may therefore differ when other fabrics or processing conditions are used. Further research could examine additional fabric types, different mordant concentrations, and variations in steaming conditions. Testing colorfastness under other conditions would also provide a broader understanding of the potential use of jomok tree bark (*Artocarpus elasticus*) as a natural dye for textile applications.

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