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The Effect of Alum, Tunjung, and Betel Lime Mordants on Ecoprinting Insulin Leaves Using Combined Pounding and Blanket Techniques on Yamaha Silk Dyed with Gambir Extract

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ABSTRACT - The rapid growth of the textile industry has made it one of the largest contributors to environmental pollution, particularly through waste generated during the large-scale color refinement of synthetic textiles. A sustainable alternative to mitigate this issue is the use of eco-friendly textile dyeing methods such as *ecoprint*. This study aims to examine the effects of three mordant types—alum, ferrous sulfate (*tunjung*), and betel lime—on the ecoprint results of insulin leaves (*Smallanthus sonchifolius*) applied to Yamaha Silk fabric using a combination of pounding and blanket techniques. Employing a quantitative experimental method, the research used Yamaha Silk fabric ecoprinted with insulin leaves and gambier extract, treated with pre-mordanting. Primary data were collected from evaluations by 15 panelists (three lecturers and twelve students) through a questionnaire assessing various indicators. Data were analyzed using the Friedman K-Related Samples test via SPSS. The findings revealed that the color outcomes (hue) varied by mordant: without mordant produced a Golden Sundance color; alum resulted in Soft Brown; *tunjung* yielded Olive; and betel lime produced Dark Brown. Regarding motif clarity, alum mordant achieved the highest clarity, followed by no mordant, betel lime, and *tunjung*. A significant difference was observed among treatments for motif clarity (Asymp. Sig = 0.005 < 0.05). In terms of color fastness, after one washing, alum mordant maintained the most stable color, followed by *tunjung* and betel lime. Significant differences in color fastness were also recorded after two and three washings (p = 0.013, 0.036, and 0.004, respectively; all < 0.05). Overall, the use of alum mordant produced the best ecoprinting results on Yamaha Silk, yielding superior color intensity, motif clarity, and wash fastness. These results suggest that the ecoprinting technique, particularly with alum mordant, holds strong potential as an environmentally friendly alternative in sustainable textile production.

Keywords: Ecoprint, insulin leaves, mordant, Gambir, Yamaha silk.

INTRODUCTION

The textile industry plays a vital role in supporting Indonesia’s economy; however, it is also one of the largest contributors to environmental pollution due to waste generated from synthetic dyeing processes. The large-scale use of chemical dyes in textile production results in significant wastewater discharge, which threatens ecosystems and human health. As global awareness of sustainability grows, the textile industry has begun adopting the concept of eco-fashion, which emphasizes the use of environmentally friendly materials, sustainable production practices, and efficient energy utilization (Hatef Jalil & Shaharuddin, 2020).

One of the emerging eco-friendly alternatives in textile coloring is ecoprinting—a natural dyeing technique that uses leaves, flowers, or other plant materials to imprint motifs directly onto fabric surfaces. According to Syafril & Agel (2024), ecoprinting is the process of applying plant materials to fabric to produce distinctive natural motifs. This technique is recognized as a sustainable approach because it minimizes chemical waste and relies on biodegradable color sources (D. S. & Alvin, 2019). The uniqueness of ecoprinting lies in its unpredictable yet artistic results; the final colors and motifs depend on variables such as plant species, fabric type, mordant composition, and the chosen technique (Hikmah & Retnasari, 2021).

Among the various plants used in ecoprinting, insulin leaves (*Smallanthus sonchifolius*) show considerable potential. These leaves possess a palmate shape with serrated edges and well-defined vein structures, enabling them to produce sharp and visually appealing motifs when applied to fabric (Hidayat & Napitupulu, 2015). Furthermore, insulin leaves contain natural colorant compounds such as flavonoids, tannins, and polyphenols, which enhance the vibrancy and color stability of the resulting ecoprints (Thakker & Sun, 2021). Their moderately firm yet flexible texture also makes them ideal for printing processes.

The technique employed in ecoprinting significantly influences the final visual quality. As stated by Nurmasitah et al. (2023), the ecoprinting process is unique and non-replicable—no two outcomes are identical, even when using the same materials. Commonly used techniques include hammering, pounding, steaming, and hapazome methods. In this study, a combination of pounding and blanketing techniques was employed. The pounding method involves physically beating the leaves to extract pigments directly onto the fabric, while the blanketing method uses a secondary cloth (dyed with natural pigments) to transfer color during steaming. This combination allows for more uniform, sharper colors and clearer motif patterns (Ristiani et al., 2020). The blanket fabric was pre-dyed with gambier extract (*Uncaria gambir* Roxb.), which contains high concentrations of catechins and tannins known for their strong colorfastness (Viena & Nizar, 2018).

The fabric medium also plays an essential role in ecoprinting. This research used Yamaha silk, a blended fabric consisting of silk and polyester fibers. Based on preliminary burn tests, this fabric demonstrated strong compatibility with natural dyes and provided a smooth, glossy surface that effectively captured printed motifs.

To ensure that the natural pigments from plants adhere well to the fabric fibers, a mordant—a color-binding agent—is required. Mordants enhance the bonding between dye molecules and fibers, improving color intensity and durability. The mordants used in this study were alum (potassium aluminum sulfate), tunjung (ferrous sulfate), and betel lime (calcium hydroxide). These mordants are not only environmentally friendly and easily accessible but also capable of producing distinct color variations (Wahyuni & Novrita, 2024). Mordanting can be carried out through three methods: pre-mordanting, meta-mordanting, and post-mordanting (Repon et al., 2024). Following the recommendations of Pancapalaga et al. (2022), this study employed the pre-mordanting technique, considered the most effective because it allows mordant absorption before the dyeing process begins.

Preliminary tests showed that the use of different mordants had a substantial impact on both color and motif clarity. The alum mordant produced a soft brown hue, tunjung generated a dark brown hue, and betel lime yielded an olive tone. In terms of motif clarity, alum mordant produced very clear imprints, tunjung produced clear motifs, and betel lime resulted in moderately clear impressions. Furthermore, the wash fastness tests revealed that samples treated with alum and tunjung mordants maintained their color stability, while those treated with betel lime experienced slight fading.

Based on these findings, this research aims to further examine the influence of alum, tunjung, and betel lime mordants on the color hue, motif clarity, and washing fastness of insulin leaf (*Smallanthus sonchifolius*) ecoprints produced using a combination of pounding and blanketing techniques on Yamaha silk fabric.

METHOD

This research is a type of quantitative research.*experimental* with yamah silk fabric which is given an ecoprint motif of insulin leaves and gambir extract with alum, tunjung, and betel lime mordant with a combination of pounding and blanket techniques.The research procedure consists of three main stages (1) ecoprint preparation (2) data collection using an instrument in the form of a questionnaire containing indicator scores regarding color names (*hue*), clarity of leaf motif shape and color fastness to washing assessed by 3 panelists who are lecturers who have experience teaching textile courses and have a SK in the field as well as 12 students who have completed the textile knowledge course with a grade of A (3) data analysis using the Friedman K-Related Sample test which is an alternative to the ANOVA test, with information handling using the SPSS program *(Statistical Product and Service Solutions).*

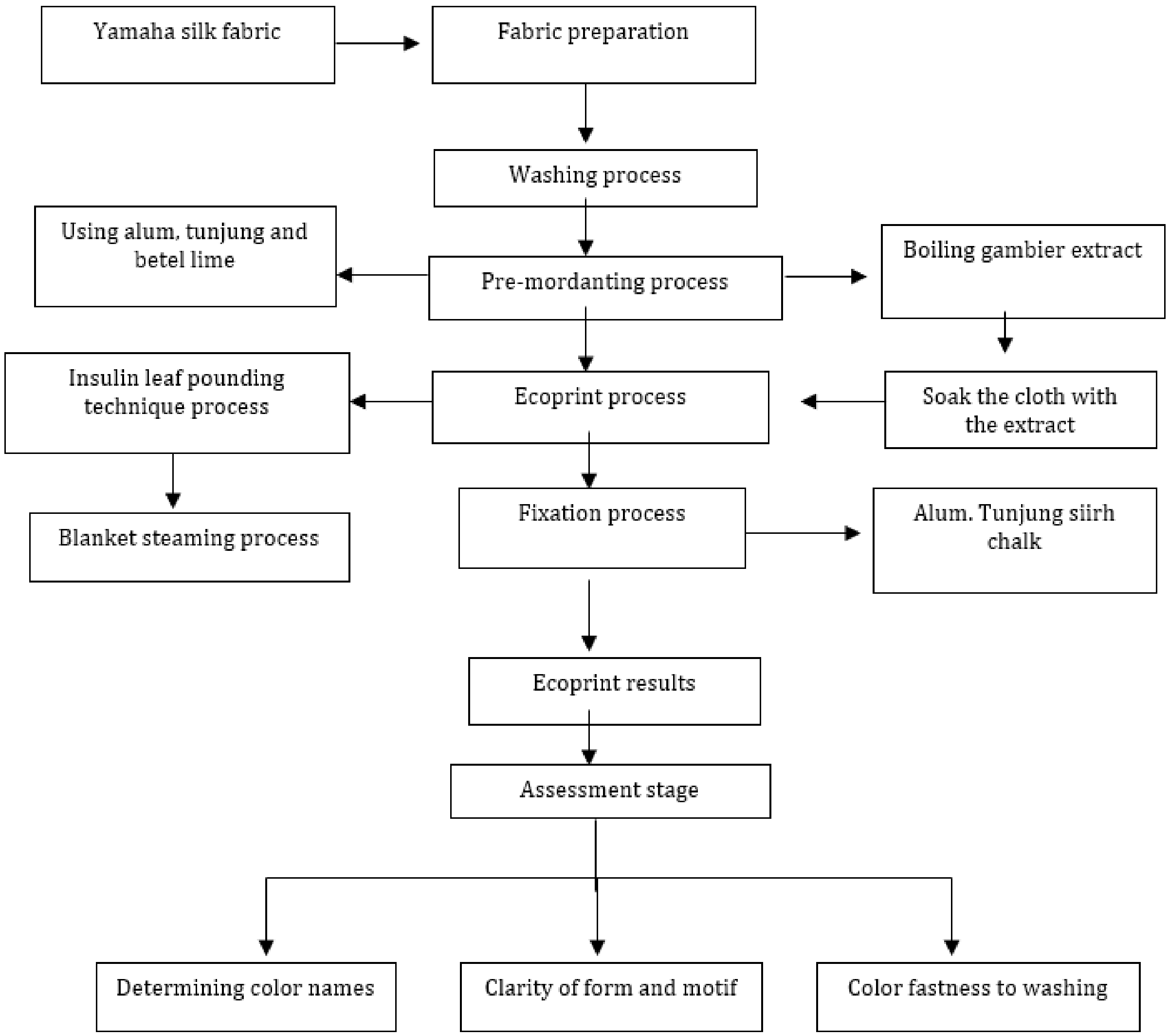

FIGURE 1. Research flow.

RESULTS AND DISCUSSION

The results of the description of the color name, clarity of the leaf motif shape and color fastness were assessed by 15 panelists. To determine the difference in clarity of the leaf motif shape and color fastness to washing, the data was processed using the SPSS application with the Friedman K-Related Sample test. This resulted in the results of the insulin leaf ecoprint.*(Smallanthus sonchifolius)* without mordant, alum mordant, tunjung, and betel lime.

Color Names

Color names are needed as a color identity to distinguish it from other colors. In this study, color names were searched using the application *Colorblind Assistant*. Based on the results of the highest points of the panelists' assessment, it is known that the results of the insulin leaf ecoprint *(Smallanthus sonchifolius)* without mordant, mordant alum, tunjung, and lime betel can be seen in tables 1, 2 and 3

TABLE 1. Description of the results of the research on the color names (hue) of leaf blades.

Mordant	**Color**	**Name Color**	**Color code**	**RGB**
Without Mordan		*Golden Sundance*	# BFB2C3C	R 191 G 128 B 060
Mordant Alum		*Soft brown*	#908452	R 141 G 132 B 050
Mordant Tunjung		*Olive*	#6E6C63	R 099 G 094 B 078
Mordant Lime betel		*Dark Brown*	#96653C	R 120 G 088 B 050

TABLE 2. Description of the results of the research on the color names (hue) of the leaf veins.

Mordant	**Color**	**Name Color**	**Color code**	**RGB**
Without Mordan		*Light brown*	# E8DD78	R 232 G 221 B 120
Mordant Alum		*Golden Sundance*	#C8AD58	R 181 G 165 B 071
Mordant Tunjung		*Tan* Gray (52%White)	#84837B	R 134 G 132 B 128
Mordant Lime betel		*Muddy maters Brown*	#A28B7B	R 191 G 141 B 071

TABLE 3. Description of the results of the research on the color names (hue) of the leaf.

Mordant	Color	Name Color	Color code	RGB
Without Mordan		*Cannary Yellow*	#D6CB69	R 214 G 203 B 100
Mordant Alum		*Muddy Waters Brown*	#8E8142	R 169 G 159 B 108
Mordant Tunjung		*Olive*	#716F63	R 113 G 111 B 099
Mordant Lime betel		*Muddy Maters Brown*	#B8904A	R 194 G 154 B 085

Clarity of Leaf Motif Shape

The clarity of the leaf motif shape can be seen through the printed results of the insulin plant motif shape (*Smallanthus sonchifolius*) in the form of leaf blades, leaf veins and leaf branch veins. On the fabric yamaha silk The mean values were obtained as follows: without mordant the average was 3.07, alum mordant the average was 3.73, tunjung mordant the average was 2.80 and betel lime mordant the average was 3.20. The results of the *Friedman K-Related Sample* test for the clarity of the motif shape can be seen in table

TABLE 4. Friedman K-related sample test for clarity of leaf motif shape.

Test Statistics[a]	
N	15
Chi-Square	13.037
Df	3
Asymp. Sig.	.005

a. Friedman Test

From the table above, it can be concluded that the clarity test of the Friedman K-Related Sample leaf motif shape was produced by the influence of alum, tunjung, and betel lime mordants on the results of insulin leaf ecoprints.*(Smallanthus sonchifolius)*on Yamaha silk fabric with a combination of techniques pounding And blanket A significance value of 0.005 was obtained, which is smaller than the significance level of 0.05 or 0.005 < 0.05. This shows that without mordant and using different mordant, insulin leaf ecoprinting makes a difference in the clarity of the leaf motif shape.

Color Fastness to Washing

Color fastness is obtained from the results of washing using liquid detergent. Based on the results of the analysis of color fastness data in 1 wash with an assessment by 15 panelists, the mean value of color fastness to washing is as follows: one wash of the fabric yamaha silk 1 wash without mordant 4.07, 1 wash with alum mordant got an average of 4.80, 1 wash with tanjung mordant got an average of 4.67, and 1 wash with lime mordant got an average of 4.53

TABLE 5. Friedman K-related sample test for fastness to 1 washing using mordants alum, tunjung, and lime.

Test Statistics[a]	
N	15
Chi-Square	10.842
Df	3
Asymp. Sig.	.013

a. Friedman Test

The Friedman K-Related Sample test for color fastness to washing in 1 wash using liquid detergent produced a smaller value of 0.013 with a significance level of 0.05 or 0.013 < 0.05. This shows that in 1 wash using insulin leaves*(Smallanthus sonchifolius)* on Yamaha silk material produced a significant difference in the fastness test. Thus, the use of insulin leaves (*Smallanthus sonchifolius*) as a natural dye in Yamaha silk material shows significant differences in color fastness to washing, which can be influenced by the treatment or washing conditions

Color fastness is obtained from the results of washing using liquid detergent. Based on the results of the analysis of color fastness data on 2 washings with an assessment by 15 panelists, the mean value is as follows: 2 washings without mordant got an average of 3.60 2 times washing with alum mordant got an average of 4.40, 2 times washing with tunjung mordant got an average of 4.07, and 2 times washing with betel lime mordant got an average of 4.00

TABLE 6. Friedman K-related sample test for fastness to 2 washings using mordants alum, tunjung and betel lime.

Test Statistics[a]	
N	15
Chi-Square	8.536
Df	3
Asymp. Sig.	.036

a. Friedman Test

The Friedman K-Related Sample test for color fastness to washing in 2 washes using liquid detergent produced a smaller value of 0.036 with a significance level of 0.05 or 0.036 < 0.05. This indicates that there is a significant difference in color fastness to 2 washes on Yamaha silk material dyed using insulin leaves (*Smallanthus sonchifolius*), both after 1 and 2 washes. This means that the washing treatment has a real effect on the change in color fastness of the material

Color fastness was obtained from the results of washing using liquid detergent. Based on the results of the analysis of color fastness data in 3 washings with an assessment by 15 panelists, the following mean values were obtained: 3 washings without mordant got an average of 3.33, 3 washings with alum mordant got an average of 3.33.average 4.27, 3 times washing with tunjung mordant got an average of 4.20, and 3 times washing with betel lime mordant got an average of 4.07.

TABLE 7. Friedman K-related sample fastness test against 3 washing times using mordant alum, tunjung and betel lime.

Test Statistics[a]	
N	15
Chi-Square	13.096
Df	3
Asymp. Sig.	.004

a. Friedman Test

The Friedman K-Related Sample test for color fastness to washing in 1 wash using liquid detergent soap produced a value of 0.004 which was greater with a significance level of 0.05 or 0.004<0.05. This shows that the use of insulin leaves (*Smallanthus sonchifolius*) as a natural dye in Yamaha silk material makes a significant difference in color fastness after washing 1, 2, and 3 times. Thus, the more often the material is washed, the more significant the effect on color fastness changes.

Discussion

Name Color

Based on research findings and panelist assessments, the hue of ecoprinted insulin leaves (*Smallanthus sonchifolius*) on Yamaha silk can be identified as follows. Without mordant, the leaves produced a hue named Golden Sundance; with alum mordant, the hue was Soft Brown; with tunjung (ferrous sulfate) mordant, the hue appeared as Olive Lime; and with lime mordant, the resulting hue was Dark Tan. Ecoprinting on mother tulag leaves without mordant produced a Light Brown hue, while alum mordant generated a Golden Sundance tone. Using tunjung mordant resulted in a Gray (52 % White) hue, and lime mordant produced a Muddy Matters Brown tone. Meanwhile, the branch veins of the insulin leaves printed on Yamaha silk produced Canary Yellow without mordant, Muddy Waters Brown with alum mordant, a dark hue close to Muddy Waters Brown with tunjung mordant, and Muddy Matters Brown with lime mordant.

The variation in color hues obtained from the ecoprinting process is influenced by the type and pH level of the mordant used. This finding aligns with Ren et al. (2016), who stated that the acidity level of the dye bath significantly affects color brightness, with lower pH producing brighter shades. Similarly, Repon et al. (2024) explained that the interaction between mordant ions and natural pigments depends on pH; acidic mordants enhance light hues, while alkaline mordants deepen the color tone.

In this study, ecoprinting using alum mordant produced a Soft Brown hue with a slightly greenish tone, consistent with Uddin (2014), who found that alum mordant on silk generated light brown shades due to its mildly acidic character (pH 6–7). These results indicate that the Soft Brown hue is influenced by the acidity of alum, which leads to brighter pigments. In contrast, ecoprinting with tunjung mordant resulted in an Olive hue with dark or dense grayish tones. This observation is in agreement with Burkinshaw & Kumar (2009), which reported that ferrous sulfate mordant ($FeSO_4$) produces darker hues because of its basic nature (pH 8–10) and strong metal–pigment complex formation. The Olive hue in this study is therefore attributed to the alkaline property of tunjung and the longer wavelength of reflected light that yields darker shades.

Furthermore, the use of lime mordant produced a Dark Brown color with orange and deep brown undertones. According to İşmal & Yıldırım (2019), alkaline mordants such as lime (pH ≈ 8) create warmer and deeper tones by increasing pigment stability in basic media. This is also supported by Zulikah & Adriani (2019), who found that brownish hues frequently emerge in natural dyeing when lime or chalk mordants are used. Thus, the Soft Brown color observed in this study is affected by the alkaline nature of lime, which, owing to its short light wavelength reflection, produces warm yet bright brown shades.

Overall, these findings demonstrate that the hues produced in the ecoprinting process of insulin leaves (*Smallanthus sonchifolius*) on Yamaha silk are determined by the pigment content of the leaves—such as flavonoids, anthocyanins, and tannins—and by the acidity or alkalinity (pH) of the mordant used. Together, these factors influence both the direction and intensity of the resulting colors.

Clarity of shape and motif

The clarity of a leaf's imprint in the ecoprinting process is strongly influenced by the texture of its underside. Insulin leaves exhibit a palmate or lobed form with pronounced segments and pointed tips. Their undersides have distinct grooves, serrated edges, and a firm yet flexible surface, allowing the leaf to press evenly onto the fabric so that the resulting ecoprint accurately reflects the leaf's shape and texture. However, the printed hue often differs from the original leaf color because the prominent veins on the leaf underside influence pigment transfer. Studies on leaf-based ecoprinting have shown that alum mordant tends to produce sharper motif definitions and clearer forms compared to non-mordanted samples (Nida et al., 2024).

Beyond leaf texture, the type of mordant also affects motif clarity. Research by Nurmasitah et al. (2022) revealed that different mordants, such as tawas (alum), tunjung (ferrous sulfate), and tannins, significantly influence the contrast and sharpness of the resulting motifs. Additionally, combining pounding and blanket transfer techniques enhances motif clarity because the applied pressure and heat promote pigment movement along the leaf–fabric interface, highlight vein structures, and increase color density (Mohamed et al., 2024). In this study, ecoprints made without mordant, as well as those using tunjung and betel lime, produced clear motifs, whereas alum mordant yielded very clear form definition. Therefore, alum mordant was found to be the most effective in achieving motif clarity for insulin leaf prints.

The clarity of shape and color is also affected by the characteristics of the fabric and the mordant used. Yamaha silk, utilized in this study, is a mixed-fiber fabric with tightly woven threads and good water absorption capacity. Its dense weave allows pigments to adhere well and replicate detailed leaf features, such as veins and edges. This finding aligns with the general principle that fabrics with tighter weave densities exhibit better pigment absorption and result in denser colors (Ng et al., 2014). Furthermore, the combination of pounding and blanket techniques enhances both color vibrancy and motif clarity, especially when applied to leaves with strong vein structures like insulin leaves (Mohamed et al., 2024).

Fastness of washing

The ecoprint test was conducted to evaluate the reduction of color pigments in samples treated with different mordants—alum, tunjung (ferrous sulfate), and betel lime. The findings showed that ecoprinted insulin leaf samples using alum and tunjung mordants exhibited higher washing fastness compared to those using betel lime. After the first wash, samples with alum and tunjung mordants showed no visible change, whereas the sample treated with betel lime displayed minor fading. After the second wash, alum and tunjung mordants still maintained good color stability with only slight changes, while the betel lime sample experienced noticeable pigment loss. This result supports the findings of Wang et al. (2016), who noted that alkaline soap solutions tend to reduce the stability of anthocyanin compounds in leaves, making them more soluble and decreasing color fastness during detergent washing.

Alum mordant demonstrates strong wash resistance because its aluminum ions (Al^{3+}) form stable coordination bonds between dye molecules and fabric fibers, enhancing pigment fixation. The compound potassium alum ($KAl(SO_4)_2 \cdot 12H_2O$) is particularly effective in maintaining dye stability. Similarly, the tunjung mordant, which contains ferrous sulfate ($FeSO_4$), strengthens the interaction between dye molecules and fabric fibers by forming metal–dye complexes that stabilize color and pattern retention during washing. These results are consistent with research by Diva & Novrita (2023), who found that ecoprinted kenikir leaves on cotton fabric using alum mordant maintained their color and motif with no visible change after washing. Likewise, Rana et al. (2022) reported that alum mordant improved color fastness when used in dyeing with rosella flower petal extract.

In addition to mordant type, the nature of the fabric also affects washing durability. Yamaha silk, used in this study, is a blended fabric composed of natural and synthetic fibers, which contributes to its fade-resistant properties. (Leha & Khayati, 2022) explained that fabrics made of blended or synthetic fibers exhibit better wash fastness values, making them suitable for ecoprinting applications. This aligns with the findings of Ningtarich et al. (2025), who observed that wash fastness tests on cotton, silk, and linen fabrics consistently produced scores between 4 and 5 on the gray scale, categorized as "good" to "very good." Therefore, both the choice of mordant and the fabric composition play key roles in determining the overall wash durability of ecoprinted materials.

Differences in the effects of no mordant, alum mordant, tunjung mordant, and lime mordant using betel leaves on the ecoprint results of insulin leaves on Yamaha silk fabric were observed in terms of shape clarity and color fastness to washing

The results of the ecoprint process using insulin leaves indicate that the resulting color tones are strongly influenced by the type of mordant applied. Mordants serve as generating or binding agents and can possess either acidic or basic properties. Generally, a more acidic mordant produces lighter color tones, whereas a more basic mordant results in darker hues. In this study, the mordants used—alum, tunjung (ferrous sulfate), and betel lime—exhibit varying pH characteristics that directly affect the resulting color appearance on Yamaha silk fabric.

The findings show that differences in mordant composition led to variations in pH, producing significant differences in the resulting color hues. This observation aligns with the study of Benli (2024), who explained that the pH level of mordant solutions plays a crucial role in determining color brightness and stability: acidic mordants yield lighter shades, while alkaline mordants generate darker tones. Similarly, Uddin (2014) confirmed that the higher the pH level, the darker and less vibrant the resulting color of natural dyes on silk fabrics.

Beyond hue differences, the clarity of the printed leaf motif is also influenced by the mordant used. The analysis of motif clarity in this study revealed visible distinctions among the samples prepared with no mordant, alum, tunjung, and betel lime. Consistent with this finding, Khoirotul Amaliyah et al. (2024) reported that the clarity of ecoprint motifs depends on the surface texture of leaves, including their veins and branching patterns, which interact differently with various mordant treatments. Statistical analysis using the Friedman K-related samples test in the present study showed a significance value of 0.005 (< 0.05), indicating a significant difference in motif clarity across treatments. Thus, the hypothesis (H_0) was rejected, confirming that mordant type significantly affects leaf motif clarity in insulin leaf ecoprints on Yamaha silk.

The Friedman K-related samples test was also applied to evaluate color fastness to washing. Results revealed significant changes in color retention between treatments. After the first wash, the significance value was 0.032 (< 0.05); after the second wash, 0.007 (< 0.05); and after the third wash, 0.001 (< 0.05). These results indicate that the mordant type significantly affects washing fastness. Samples treated with alum and tunjung mordants maintained their color and pattern more effectively than those treated with betel lime. This finding is consistent with Rahmawati et al. (2023), who found that mordant type significantly influenced both motif clarity ($p = 0.013 < 0.05$) and color fastness to washing ($p = 0.001 < 0.05$) in cotton ecoprints. Similarly, the work of Shahmoradi Ghaheh et al. (2021) and Jose et al. (2017) supports the conclusion that metallic mordants, such as alum and ferrous sulfate, form stable coordination bonds with dye molecules, enhancing color retention and pattern definition.

CONCLUION

Color name*(hue)* results ecoprint insulin leaves on cloth yamaha silk without mordant, on the leaves produce color golden sundance, with alum mordant, on the leaf sheet produces color soft brown, with the tunjung mordant, the leaf blades produce color olive, with lime mordant, the leaf blades produce color Dark tan Selecting insulin leaves: Choose insulin leaves that are neither too old nor too young. It is recommended to choose leaves that are still fresh and not damaged (with holes) so that the process of transferring the color and shape of the ecoprint can produce colors and shapes that can be printed well.

clarity of the leaf motif shape in the results ecoprint insulin leaves on the cloth yamaha silk Without mordant, 66% of panelists stated it was clear, alum mordant, 73% of panelists stated it was very clear, tunjung mordant, 53% of panelists stated it was clear, betel lime mordant, 46% of panelists stated it was clear, the use of awas mordant in the insulin leaf ecoprint technique on Yamaha silk material was very good, the higher the p*H* contained, the brighter and clearer the resulting motif will be.

Color Fastness to 1 Wash ecoprint insulin leaves on the cloth yamaha silk alum mordant using liquid detergent soap, the assessment results for the first wash had a score of 72, the panelists stated there was no change. The second wash had a final score of 66, the panelists stated there was a slight decrease/change and the third wash had a final score of 64, stating there was a slight decrease change.

Color fastness to 2 washes on fabric yamaha silk Using alum mordant with liquid detergent for the first wash had a final score of 70, the panelists stated that there was no change. In the second wash, the final score was 63, the panelists stated that there was a slight decrease/change and the third wash had a final score of 61, the panelists stated that there was a slight change.

Color fastness to 3 washes on fabric yamaha silk Using lime mordant with liquid detergent soap for the first wash had a final score of 68, the panelists stated that there was no change. In the second wash, the final score was 61, the panelists stated that there was a slight decrease/change, and the third wash had a final score of 60, the panelists stated that there was a visible change. Better color fastness to washing is achieved by using alum mordant.

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