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Potential of Freshly Fallen *Elaeocarpus ganitrus* Leaves as a Sustainable Ecoprint Biomaterial

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Abstract
The textile industry continues to face environmental challenges due to the intensive use of synthetic dyes and chemical processing, encouraging the exploration of sustainable biomaterials for textile production. Ecoprint has emerged as an environmentally friendly textile coloration technique; however, most studies still rely on fresh leaves harvested directly from plants. This study aimed to describe the ecoprint production process using newly fallen *Elaeocarpus ganitrus* leaves and to evaluate the quality of the resulting ecoprints. A descriptive quantitative approach with a comparative design was employed using five treatment variants: fresh leaves, untreated newly fallen leaves, steamed newly fallen leaves, vinegar-treated newly fallen leaves, and alcohol-treated newly fallen leaves. Ecoprints were produced on silk-cotton fabric using the steam ecoprint technique. Product quality was evaluated by seven expert panelists based on five indicators: motif clarity, sharpness of leaf vein detail, color intensity, color evenness, and overall aesthetic quality. Data were analyzed using descriptive statistics and the Friedman test. The results showed that all treatment variants produced ecoprints with good to very good quality. Untreated newly fallen leaves achieved the highest overall mean score (4.08), whereas steamed leaves recorded the lowest (3.91). However, the Friedman test indicated no statistically significant differences among treatments across all quality indicators ($p > 0.05$). These findings demonstrate that newly fallen *Elaeocarpus ganitrus* leaves can be directly utilized as an alternative ecoprint biomaterial without requiring additional pre-treatment, thereby simplifying the production process while supporting more sustainable utilization of local plant biomass.

Keywords: *biomaterial, Di Elaeocarus ganitrus, ecoprint, falen leaves, sustainable textiles*

INTRODUCTION

The textile industry is one of the manufacturing sectors that contributes significantly to global economic growth, but is also one of the main contributors to environmental problems. The dyeing (*dyeing*) and finishing (*finishing*) stages are the processes that consume the most water, energy, and chemicals, resulting in wastewater with a high pollutant content (Hidayah, Rahmatillah, & Mahfudzoh, 2025). The use of synthetic dyes also increases the risk of environmental pollution because some dye molecules are not perfectly fixed onto textile fibers and are discharged along with production waste (Slama et al., 2021). This condition has driven the development of various textile innovations that prioritize resource efficiency, the use of biomaterials, and the application of sustainability principles in the production process.

In line with growing attention to sustainable development, the use of natural dyes has regained attention as a more environmentally friendly alternative to synthetic dyes. Natural dyes come from renewable biological resources, have a high degree of biodegradability, and have the potential to reduce the use of hazardous chemicals in the textile dyeing process (Das & Natarajan, 2019; Yadav et al., 2023). Research developments over the past decade show that the use of natural biomaterials is no longer limited to pigment extraction as a dye, but has also expanded toward the direct use of plant parts through the ecoprint technique as one approach in the development of sustainable textiles

(Kusumastuti, Atika, et al., 2025; Nurmasitah et al., 2023). Ecoprint is a textile dyeing technique that utilizes direct contact between plant parts and the fabric surface, so that the shape, color, and morphological character of the plant transfer onto the textile medium through a rolling and steaming process. Unlike dyeing techniques that use dye extracts, ecoprint preserves the natural character of the leaf, producing unique motifs that cannot be replicated identically. This uniqueness makes ecoprint regarded not only as a textile decoration technique, but also as a form of utilizing local biodiversity that integrates aesthetic value, creativity, and sustainability (Dobriyal & Sarkar, 2025; Yanti Damayanti et al., 2025).

The quality of ecoprint results is influenced by various factors, including the characteristics of the biomaterial, fabric type, production technique, mordant use, and the plant's secondary metabolite content. Various studies have explored the use of diverse leaf species as sources of natural motifs, since each species has different morphological shapes, leaf vein patterns, pigment content, phenolic compounds, flavonoids, and tannins, resulting in a variety of motif and color characteristics (Kuljarusnont et al., 2024; Nurlela et al., 2022; Tessariol, 2025). These findings indicate that the selection of biomaterial is an important factor in determining the quality of ecoprint results (Fuad et al., 2025; Kusumastuti, Atika, et al., 2025; Nurmasitah et al., 2023). The development of ecoprint research also shows that most of the biomaterials used still come from fresh leaves picked directly from the plant. This approach is chosen because fresh leaves are considered to still have optimal pigment content, thereby producing clearer motifs. However, the continuous use of fresh leaves has the potential to increase the utilization of the plant's vegetative biomass, especially if the ecoprint technique is applied at a production scale. This condition opens opportunities to explore other biomaterial sources that are more in line with sustainability principles, one of which is the use of naturally fallen leaves.

The utilization of fallen plant biomass is an approach in line with the concept of a *circular bioeconomy*, namely maximizing the added value of biomass without increasing the exploitation of biological resources (Pizzicato et al., 2023). Freshly fallen leaves still retain an intact morphological shape, so that conceptually they have the potential to be used as natural motif formers in the ecoprint process. In addition to reducing the need for picking fresh leaves, the use of fallen leaves also provides an alternative use of biomass that has not been widely utilized in sustainable textile practices. Nevertheless, scientific studies on the use of freshly fallen leaves as an ecoprint biomaterial are still relatively limited, requiring further exploration.

One species with prospects for development as a textile biomaterial is *Elaeocarpus ganitrus*. This plant has so far been better known as a producer of *rudraksha* seeds, which are used in traditional health, culture, and craft fields. Recent research developments have begun to show that *Elaeocarpus ganitrus* leaves also have potential in the textile field. Hidayah, Rahmatillah, Mahfudzoh, et al. (2025) reported that *Elaeocarpus ganitrus* leaf extract can be used as a natural dye on lyocell, rayon, and cotton fabrics. That study showed that the ethanol maceration method produced a higher *color strength* (*K/S*) value compared to the boiling method, so that *Elaeocarpus ganitrus* leaves have the potential to be developed as an environmentally friendly source of textile dye. This finding reinforces that *Elaeocarpus ganitrus* leaves have prospects as a textile biomaterial, although that study was still oriented toward the use of leaf extract as a dye source.

In addition to being a source of natural dye, *Elaeocarpus ganitrus* leaves have also begun to be used as motif formers in ecoprint. Sholikhah & Widowati (2024) used *Elaeocarpus ganitrus* leaves in the *steam medium print* technique with variations of alum, iron, and quicklime mordants. The research results showed that the type of mordant affected color fastness, color depth, and the aesthetics of the ecoprint motif. That study proved that *Elaeocarpus ganitrus* leaves are able to produce ecoprint motifs whose quality is influenced by the mordanting treatment. However, the biomaterial used was still fresh leaves obtained through picking, so it did not provide information on the possibility of using naturally fallen leaves.

A review of previous research shows that the use of *Elaeocarpus ganitrus* in the textile field has developed through two main approaches, namely as a source of natural dye extract and as a motif-forming biomaterial for ecoprint (Hidayah, Rahmatillah, Mahfudzoh, et al., 2025; Sholikhah & Widowati, 2024). To date, no research has specifically explored the use of freshly fallen *Elaeocarpus ganitrus* leaves as an ecoprint biomaterial or described the production process and quality of the resulting ecoprint. This gap indicates that the utilization of fallen *Elaeocarpus ganitrus* leaf biomass still leaves an important space for research, particularly in supporting the development of more sustainable textile biomaterials.

Unlike previous studies that used leaf extracts or fresh leaves obtained through picking, this study explores freshly fallen *Elaeocarpus ganitrus* leaves as an ecoprint biomaterial. This approach offers a new perspective on the utilization of plant biomass because it uses leaves that have fallen naturally without increasing plant exploitation. This study also not only describes the ecoprint production process, but also evaluates the quality of the resulting ecoprint as a scientific basis for the development of sustainable textile biomaterials. Based on the description above, this study aims to (1) describe the process of making ecoprint using freshly fallen *s* leaves as a natural biomaterial, and (2) describe the quality of ecoprint results using freshly fallen *Elaeocarpus ganitrus* leaves. The results of this study are expected to expand the utilization of plant biomass in the textile field and provide an alternative ecoprint biomaterial that is more in line with sustainability principles.

METHOD

This study used a descriptive quantitative approach with a comparative design to describe the ecoprint production process and evaluate the quality of ecoprint results using *Elaeocarpus ganitrus* leaves under various treatments. The descriptive approach was used to describe the characteristics of ecoprint quality based on panelist assessments, while the comparative design was used to determine whether there were differences in ecoprint quality among treatment variants (Creswell & Poth, 2018). The main materials used in this study consisted of silk-cotton fabric, *Elaeocarpus ganitrus* leaves, alum, iron mordant, industrial vinegar, 70% alcohol, water, wrapping plastic, and binding rope. Silk-cotton fabric was chosen because it has good absorption of natural pigments, enabling it to produce clearer ecoprint motifs. This study used five biomaterial treatment variants, namely:

- **Variant A** : fresh *Elaeocarpus ganitrus* leaves picked directly from the plant;
- **Variant B** : freshly fallen *Elaeocarpus ganitrus* leaves without treatment;
- **Variant C** : freshly fallen *Elaeocarpus ganitrus* leaves steamed for 5 minutes to restore the leaf tissue's moisture;
- **Variant D** : freshly fallen *Elaeocarpus ganitrus* leaves soaked in a mixture of industrial vinegar and water for 2 hours;
- **Variant E** : freshly fallen *Elaeocarpus ganitrus* leaves soaked in a mixture of 70% alcohol and water for 2 hours.

All variants used an ecoprint production procedure with the *steam ecoprint* technique, modified from the procedure of Sholikhah and Widowati (2024). The fabric was first mordanted using a solution consisting of 30 g of alum and 30 g of iron mordant dissolved in 2.5 L of water. After the mordanting process was complete, the leaves were arranged on the fabric surface according to each treatment, after which the fabric was folded, rolled onto a pipe, wrapped in plastic, and tied tightly before the steaming process. Once the roll reached room temperature, the fabric was unwrapped and the fixation process continued using a solution of 15 g of alum in 1 L of water, then air-dried in a shaded place until the ecoprint results were obtained. The research instruments consisted of an observation sheet for the ecoprint production process and an assessment sheet for the quality of the ecoprint results. Quality assessment was carried out by 7 expert panelists with competence in fashion, textiles, and ecoprint. The quality of the ecoprint results was assessed based on five indicators, namely:

1. motif clarity;
2. sharpness of leaf vein detail;
3. color intensity;
4. color evenness; and
5. aesthetics of the ecoprint result.

Each indicator was assessed using a five-point Likert scale with a score range of 1–5, where a higher score indicates better ecoprint quality. The content validity of the instrument was determined using Aiken's V based on expert assessments (Aiken, 2016). The reliability of the assessment results among panelists was analyzed using the Intraclass Correlation Coefficient (ICC) according to the guidelines proposed by (Prasetyaningtyas et al., 2023, 2024, 2025). Data were analyzed using descriptive and inferential statistics. Descriptive statistics in the form of mean and standard deviation were used to describe the quality of the ecoprint results for each indicator and each treatment variant. The mean value was then interpreted into quality categories based on predetermined score intervals.

Inferential analysis was conducted using the Friedman test to determine whether there were differences in the quality of ecoprint results among the five treatment variants. The Friedman test was chosen because the data consisted of ordinal scores from assessments by the same panelists across all treatments, thus meeting the characteristics of a nonparametric *repeated measures* design (Field, 2024). The magnitude of the treatment effect was interpreted using Kendall's coefficient of concordance (Kendall's W) as an effect size measure. All statistical tests were conducted at a significance level of α = 0.05.

RESULTS AND DISCUSSION

The quality of the ecoprint results using *Elaeocarpus ganitrus* leaves was evaluated by seven expert panelists based on five indicators, namely motif clarity, sharpness of leaf vein detail, color intensity, color evenness, and aesthetics of the ecoprint result. The assessment was carried out on five treatment variants, namely variant A (fresh leaves), variant B (fallen leaves without treatment), variant C (fallen leaves steamed for 5 minutes), variant D (fallen leaves soaked in a mixture of industrial vinegar and water for 2 hours), and variant E (fallen leaves soaked in a mixture of 70% alcohol and water for 2 hours).

Figure 1. Natural ecoprint with fresh jenitri leaves

Figure 2. Natural ecoprint with fresh fallen jenitri leaves, created without treatment

Figure 3. Natural ecoprint with fresh fallen jenitri leaves that had been steamed for 5 minutes

Figure 4. Natural ecoprint with fresh fallen jenitri leaves that had been soaked in indutrial vinegar for 2 hours

Figure 5. Natural ecoprint with fresh fallen jenitri leaves that had been soaked in 70% ethanol for 2 hours

The average panelist assessment of ecoprint quality for each indicator is presented in Table

Table 1. Average Ecoprint Quality Assessment by Treatment Variant

Indicator	A	B	C	D	E
Motif clarity	3.71	4.29	3.86	4.00	3.95
Sharpness of leaf vein detail	4.07	4.25	3.96	3.68	4.14
Color intensity	4.32	3.82	4.00	4.04	3.86
Color evenness	3.86	4.04	3.86	4.18	3.86
Aesthetics of ecoprint results	3.96	4.00	3.86	3.89	4.04
Overall average	3.99	4.08	3.91	3.96	3.97

Based on Table 1, all variants obtained average scores in the good to very good category. Variant B, namely the use of freshly fallen *Elaeocarpus ganitrus* leaves without prior treatment, obtained the highest quality average of 4.08, while variant C obtained the lowest average of 3.91. The difference in averages among variants was relatively small, thus descriptively indicating that all treatments produced relatively similar ecoprint quality. Viewed by each indicator, variant B obtained the highest score for motif clarity (4.29) and sharpness of leaf vein detail (4.25). Variant A obtained the highest score for color intensity (4.32), while variant D showed the highest value for color evenness (4.18). For the aesthetics of the ecoprint result indicator, the highest score was obtained by variant E (4.04), although the difference was relatively small compared to variant B (4.00) and variant A (3.96). These findings indicate that each treatment produced different quality characteristics for each indicator, although the average differences obtained were relatively small. To strengthen the descriptive analysis results, a Friedman test was conducted to determine whether there were differences in the quality of ecoprint results among the five treatment variants based on the assessments of seven expert panelists. The test results are presented in Table 2.

Table 2. Friedman Test Results for Ecoprint Quality

Indicator	χ^2	p-value	Kendall's W
Motif clarity	3.366	0.468	0.127
Sharpness of leaf vein details	8.153	0.086	0.291
Color intensity	4.207	0.379	0.150
Color evenness	4.127	0.389	0.147
Aethetics of ecoprint resuls	0.527	0.971	0.019

The Friedman test results show that all indicators had significance values greater than 0.05. Thus, there were no significant differences in the quality of ecoprint results among the five treatment variants, whether in terms of motif clarity, sharpness of leaf vein detail, color intensity, color evenness, or aesthetics of the ecoprint result. The value of Kendall's W ranged from 0.019–0.291, indicating a very small to moderate effect size. These results indicate that the variation in treatments applied to *Elaeocarpus ganitrus* leaves has not produced a meaningful change in ecoprint quality based on the expert panelists' assessments. Since the Friedman test showed no significant difference, the analysis was not continued with a pairwise comparison test (*post hoc test*).

The main finding of this study shows that freshly fallen *Elaeocarpus ganitrus* leaves are able to produce ecoprint quality relatively equivalent to fresh leaves. The descriptive analysis results show that all variants obtained average scores in the good to very good category, while the Friedman test results show no significant difference across all ecoprint quality indicators. These findings indicate that the natural leaf-fall process has not caused a decrease in the leaf's ability to transfer morphological shape or pigment onto the fabric surface (Nadal-Sala et al., 2021). The success of ecoprint is determined not only by the condition of leaves still attached to the plant, but also by the leaf's ability to maintain its morphological structure during the printing process (Dixit, 2023). In this study, freshly fallen *Elaeocarpus ganitrus* leaves still had intact leaf blades, distinct leaf veins, and a level of flexibility that allowed good contact with the fabric surface during the steaming process. This condition allowed the leaf shape and venation pattern to still transfer onto the fabric, producing clear motifs.

The research results also show that fallen leaves without treatment (Variant B) obtained the highest average for the motif clarity and leaf vein detail sharpness indicators. This finding indicates that freshly fallen leaves have not experienced significant tissue structure degradation (Fojtová et al., 2025; Stitt et al., 1989; Thomas & Ougham, 2016). As long as the leaf is still in the early phase after falling, its constituent tissue is still able to maintain its anatomical shape, so that the motif transfer process runs optimally. In other words, the success of motif formation is more influenced by the integrity of the leaf's morphology than by its status as a fresh or fallen leaf. These findings offer a new perspective that fallen leaves are not always identical to biomass whose quality has declined (González et al., 2020; Poorter et al., 2012; Wysocka-Czubaszek & Czubaszek, 2024). Naturally fallen leaves can still be used as biomaterial without the need to pick leaves from the plant in ecoprint production. This approach has ecological value because it can reduce the exploitation of living biomass while increasing the utilization of biomass that was previously not optimally used.

This study also shows that pre-treatments in the form of five-minute steaming, soaking in vinegar solution (Kusumastuti, Atika, et al., 2025; Sholikhah & Widowati, 2024), and soaking in alcohol solution did not provide a significant improvement in ecoprint quality. Although there was some variation in the average of several indicators, the differences were not large enough to produce a statistically meaningful difference. The absence of a significant difference indicates that the initial condition of freshly fallen *Elaeocarpus ganitrus* leaves is actually adequate for use in the ecoprint process. The additional treatments applied were aimed at increasing leaf tissue moisture or accelerating pigment release. However, the research results show that these goals have not provided a real benefit to the quality of the printed results.

The five-minute steaming treatment, for example, was expected to restore leaf moisture so that pigment transfer would be better. However, steaming also has the potential to increase softening of the leaf tissue, causing some pigment to diffuse before the printing process takes place. This condition may explain why the ecoprint quality of variant C was not higher than that of fallen leaves without treatment. Soaking in vinegar solution produced the highest average for the color evenness indicator. This indicates that the acidic condition likely helped distribute pigment more evenly on the fabric surface (Shabbir et al., 2022). However, this increase was not large enough to produce a significant difference in overall ecoprint quality. Meanwhile, soaking with alcohol did not provide a consistent improvement across all indicators. Alcohol is thought to affect leaf tissue permeability, causing faster pigment release. However, premature pigment release is not always followed by an improvement in the quality of motif transfer onto the fabric surface. Therefore, the use of alcohol as a pre-treatment has not shown a practical advantage compared to the direct use of fallen leaves. The findings of this study indicate that ecoprint quality is more influenced by the leaf's natural character and the suitability of the printing process than by the pre-treatment applied (Kusumastuti, Mohd Junaidi, et al., 2025). Thus, adding a treatment stage before the ecoprint process does not always result in improved product quality.

One important contribution of this study lies in its implications for the development of sustainable ecoprint. Ecoprint practice has generally used fresh leaves picked directly from the plant, as they are considered to have higher pigment content. This study shows that this assumption needs to be reconsidered, as freshly fallen *Elaeocarpus ganitrus* leaves are able to produce relatively equivalent ecoprint quality. This finding opens up opportunities for utilizing fallen leaf biomass as an alternative material source in ecoprint production. The use of naturally fallen leaves can reduce the need to pick living leaves, thereby better supporting vegetation conservation principles. In addition, the use of fallen biomass also reflects the application of the resource efficiency concept, as it utilizes material that was previously considered organic waste.

Another equally important aspect is the simplification of the production process. The research results show that additional treatments in the form of steaming or soaking did not provide a meaningful improvement in quality. Thus, the ecoprint process can be carried out using *Elaeocarpus ganitrus* leaves that have freshly fallen without requiring more complex pre-treatment stages. This simplification of the process has the potential to reduce production time, the use of additional materials, and energy consumption, making it more consistent with the principles of sustainable textile production. This study provides a conceptual contribution to the development of biomass-based ecoprint by showing that the physiological condition of freshly fallen leaves does not necessarily limit ecoprint quality. This finding expands the understanding that the use of biomaterials in ecoprint does not have to depend on leaves picked directly from the plant but can also utilize fallen biomass that is still in an optimal morphological condition. Thus, this study introduces a new approach to the utilization of local biomass that considers not only textile quality outcomes, but also resource use efficiency and environmental sustainability.

CONCLUSION

This study shows that freshly fallen *Elaocarpus ganitrus* leaves have potential as an alternative biomaterial for ecoprint production. All treatment variants produced ecoprint quality in the good to very good category based on the indicators of motif clarity, leaf vein detail sharpness, color intensity, color evenness, and aesthetics. Although there was descriptive variation in the average of each treatment, the Friedman test results showed that the differences were not statistically significant. These findings indicate that freshly fallen *Elaocarpus ganitrus* leaves can be used directly without requiring complex pre-treatment, such as steaming or soaking in vinegar or alcohol solutions. Thus, the use of fallen leaves has the potential to simplify the ecoprint production process while supporting the more efficient and sustainable use of local biomass. Further research is recommended to examine the physical and chemical characteristics of ecoprint results, including color fastness, color stability, and analysis of the pigment content of *Elaocarpus ganitrus* leaves at various leaf maturity levels, so that its utilization as a textile biomaterial can be developed more comprehensively.

REFERENCES

Aiken, L. R. (2016). Three Coefficients for Analyzing the Reliability and Validity of Ratings. *Educational and Psychological Measurement, 45*(1), 131–142.

Creswell, J. W., & Poth, C. N. (2018). *Qualitative Inquiry & Research Design: Choosing Among Five Approaches* (4th ed.). SAGE Publications.

Das, S., & Natarajan, G. (2019). Silk Fiber Composites in Biomedical Applications. In *Materials for Biomedical Engineering: Biopolymer Fibers* (pp. 309–338). Elsevier.

Dixit, Y. (2023). The Path to Sustainability: Anticipating the Acceptance of Eco Printing Method in the Upcoming Markets. *International Journal of Humanities & Social Science: Insights & Transformations, 8*(1).

Dobriyal, A., & Sarkar, S. (2025). Greening the Textile Industry: An In-Depth Review of Eco-Printing Methods and Challenges. *Environmental Claims Journal.*

Field, A. (2024). *Discovering Statistics Using IBM SPSS Statistics* (6th ed.). SAGE Publications.

Fojtová, M., Schrumpfová, P. P., & Fajkus, J. (2025). The Leaves Fall, Yet the Tree Endures. *Cellular and Molecular Life Sciences, 82*(1).

Fuad, M., Subagyo, S., Prohimi, A. H. A., & Sakdiah, F. H. H. (2025). Revitalizing Local Economic Potential Through Ornamental Plant–Based Ecoprint Training in Malang, Indonesia. *Journal of Community Empowerment, 5*(2), 150–158.

González, W. A., López, D., & Pérez, J. F. (2020). Biofuel Quality Analysis of Fallen Leaf Pellets: Effect of Moisture and Glycerol Contents as Binders. *Renewable Energy, 147*, 1139–1150.

Hidayah, F. N., Rahmatillah, I., & Mahfudzoh, A. R. (2025). Enhancing Eco-Friendly Textile Dyeing: Comparative Analysis of Ethanol Maceration and Boiling Extraction with Lime Mordanting on Cellulose-Based Fabrics. *International Journal on Advanced Science, Engineering and Information Technology, 15*(1), 121–130.

Hidayah, F. N., Rahmatillah, I., Mahfudzoh, A. R., & Prabaswari, A. D. (2025). Eco-Dyeing Process for Textile Antibacterial Properties of Black Colour Using *Elaeocarpus ganitrus*. *AIP Conference Proceedings, 3248*(1).

Kuljarusnont, S., Iwakami, S., Iwashina, T., & Tungmunnithum, D. (2024). Flavonoids and Other Phenolic Compounds for Physiological Roles, Plant Species Delimitation, and Medical Benefits: A Promising View. *Molecules, 29*(22), 5351.

Kusumastuti, A., Atika, A., Anis, S., Abidin, Z., Mohd Junaidi, M. U., Marlangen, R., Safira, N., & Rozana, M. (2025). Natural Pigments Imprint on Lantung Bark Using Sustainable Ecoprinting Techniques: A Comparative Study of Boiling, Steaming, and Pounding Methods. *Journal of Advanced Research in Fluid Mechanics and Thermal Sciences, 132*(2), 208–221.

Kusumastuti, A., Mohd Junaidi, M. U., Safira, N., Atika, A., Anis, S., & Abidin, Z. (2025). Eco-Friendly Ecoprint Exploration on Lantung Bark: Characterisation Study. *IOP Conference Series: Earth and Environmental Science, 1516*(1), 012012.

Nadal-Sala, D., Grote, R., Birami, B., Knüver, T., Rehschuh, R., Schwarz, S., & Ruehr, N. K. (2021). Leaf Shedding and Non-Stomatal Limitations of Photosynthesis Mitigate Hydraulic Conductance Losses in Scots Pine Saplings During Severe Drought Stress. *Frontiers in Plant Science, 12*, 715127.

Nurlela, Nurfalah, R., Ananda, F., Ridwan, T., Ilmiawati, A., Nurcholis, W., Takemori, H., & Batubara, I. (2022). Variation of Morphological Characteristics, Total Phenolic, and Total Flavonoid in *Adenostemma lavenia, A. madurense*, and *A. platyphyllum*. *Biodiversitas Journal of Biological Diversity, 23*(8), 3999–4005.

Nurmasitah, S., Sangadah, S. F., & Musdalifah. (2023). The Quality of Jatropha Leaf Ecoprint Products Using Steaming and Pounding Techniques. *IOP Conference Series: Earth and Environmental Science, 1203*(1).

Poorter, H., Niklas, K. J., Reich, P. B., Oleksyn, J., Poot, P., & Mommer, L. (2012). Biomass Allocation to Leaves, Stems and Roots: Meta-Analyses of Interspecific Variation and Environmental Control. *New Phytologist, 193*(1), 30–50.

Prasetyaningtyas, W., Nurmasitah, S., Widihastuti, W., & Ghufron, A. (2025). Transformation of Assessment Practices: Evaluation of the Implementation of Differentiated Assessment in the Garment Preparation Phase at Vocational High Schools. *Jurnal Penelitian Pendidikan, 42*(2), 192–197.

Prasetyaningtyas, W., Retnawati, H., & Djidu, H. (2023). Student Preferences in Choosing Social Media as a Learning Medium in Work Degree Courses: A Conjoint Analysis. *Proceedings of the 4th Vocational Education International Conference (VEIC 2022), 1*, 289–302.

Prasetyaningtyas, W., Widihastuti, W., & Istiyono, E. (2024). Development of Learning Outcomes Assessment Instruments for Fashion Technology Courses. *Proceedings of the 5th Vocational Education International Conference (VEIC 2023)*, 869–875.

Shabbir, M. U., Adeel, S., Bokhari, T. H., Usman, M., Khosa, M. K., Ahmad, T., & Inayat, A. (2022). Eco-Friendly Acid Dyeing of Silk and Wool Fabrics Using Acid Violet 49 Dye. *Environmental Science and Pollution Research, 30*(4), 9808–9819.

Sholikhah, A. P. M., & Widowati, W. (2024). Kualitas Hasil Ecoprint Motif Daun *Elaeocarpus ganitrus* dengan ZWA Daun Ketapang Menggunakan Mordan Tawas, Tunjung dan Kapur Tohor. *Fashion and Fashion Education Journal, 13*(1), 44–51.

Slama, H. B., Bouket, A. C., Pourhassan, Z., Alenezi, F. N., Silini, A., Cherif-Silini, H., Oszako, T., Luptakova, L., Golińska, P., & Belbahri, L. (2021). Diversity of Synthetic Dyes from Textile Industries, Discharge Impacts and Treatment Methods. *Applied Sciences, 11*(14), 6255.

Stitt, M., Lilley, R. M. C., Gerhardt, R., & Heldt, H. W. (1989). Metabolite Levels in Specific Cells and Subcellular Compartments of Plant Leaves. *Methods in Enzymology, 174*, 518–552.

Tessariol, C. (2025). Eco-Printing: Embodying Botanical Aesthetics and Sustainable Innovation in Textile Design. *ZoneModa Journal, 15*(1).

Thomas, H., & Ougham, H. (2016). Introduction to a Virtual Issue on Plant Senescence. *New Phytologist, 212*(3), 531–536.

Wysocka-Czubaszek, A., & Czubaszek, R. (2024). Fallen Leaves as a Substrate for Biogas Production. *Energies, 17*(23), 6038.

Yadav, S., Tiwari, K. S., Gupta, C., Tiwari, M. K., Khan, A., & Sonkar, S. P. (2023). A Brief Review on Natural Dyes, Pigments: Recent Advances and Future Perspectives. *Results in Chemistry, 5*, 100736.

Yanti Damayanti, N., Yan Sunarya, Y., & Widiawati, D. (2025). Symbolism in Sustainability: The Role of Jasmine Motifs in Jelami Ecoprinted Silk as a Cultural Artifact. *Archives of Design Research, 38*(2), 159–177.