

Influence of fabric type variations on hand-written Batik quality using the Astoetik electric Batik stove

Dinda Hidayati, Kapti Asiatun , Sugiyem , Noor Fitrihana * , Nova Suparmanto 

Universitas Negeri Yogyakarta, Indonesia

* Corresponding Author. Email: noor_fitrihana@uny.ac.id

ARTICLE INFO

Article History

Received:

29 March 2024;

Revised:

19 September 2024;

Accepted:

25 February 2025;

Keywords

Batik learning;

Batik quality;

Electric batik stove;

Fabric type variation;

Hand-written batik

ABSTRACT

This study aims to examine (1) the quality of hand-written batik produced on different fabric types using the Astoetik electric batik stove, and (2) the influence of fabric variation on batik quality outcomes. A pre-experimental one-shot case study design was employed by referring to the visual inspection procedures of hand-written batik characteristics based on SNI 8302:2016. Data were collected through structured observations and interviews, and analyzed using descriptive statistics supported by expert judgment. The findings reveal that fabric type significantly affects batik quality, particularly the width, clarity, and consistency of batik lines. The cacah gori motif produced varying line widths across fabrics: (a) 1.2796 mm on prima fabric (good quality), (b) 1.2022 mm on primissima fabric (very good effect), (c) 0.9208 mm on rayon (good quality), (d) 0.6783 mm on silk (clear inner lines, finer strokes), and (e) 1.0303 mm on santung (good batik results). Statistical testing indicated that differences across fabric types were significant. These findings were strengthened by assessments from batik experts. Overall, the variation in fabric type produced “significantly different” batik characteristics. The study suggests that fabric variation can serve as an effective learning resource in vocational batik education and can be utilized as alternative material options in the batik industry due to their potential to produce high-quality batik products.

This is an open access article under the [CC-BY-SA](https://creativecommons.org/licenses/by-sa/4.0/) license.



INTRODUCTION

Batik is a cultural masterpiece that has been passed down through generations and continues to serve as an important cultural expression within Indonesian society (Nuriyanto, 2022; UNESCO, 2009). It has also become a source of national pride and a symbol of Indonesian cultural identity recognized both nationally and internationally (Evita et al., 2022; Febriani et al., 2023). The National Standardization Agency (BSN) highlights the significance of Indonesian Batik, acknowledging its international recognition by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) as an intangible cultural heritage of humanity on October 2, 2009 (UNESCO, 2009).

Batik refers to a handicraft technique in which dye is applied through a resist created by hot batik wax, using main tools such as a batik wax applicator (*canting*) or a stamping tool to create specific motifs that hold meaning. Traditional batik, known as batik tulis or hand-drawn batik, is crafted using a hand-held *canting* to apply hot wax, creating specific motifs imbued with meaning (Badan Standardisasi Nasional, 2019). Ensuring the quality of batik fabric is essential and requires adherence to Indonesian National Standards (SNI) to ensure the integrity of the finished products. Various factors, including the fabric material, batik wax, dyes, environmental conditions, and human resources, influence the quality of batik products (Mandegani et al., 2018).

Previous studies also show that fabric construction plays a critical role in liquid absorption and spreading, which directly influences the clarity of batik lines and the penetration of wax. Brnada et al. (2022) emphasized that the weave density and surface structure of textiles determine the extent of

adsorption and spreading of liquids, which can be applied to understanding batik wax behavior on different fabrics (Rumiyati & Oktyawati, 2020; Syakir et al., 2024).

Methods for distinguishing genuine batik products from imitations can be used visually, physically, and chemically. Visual methods can be applied by observing characteristics such as the appearance of the front and back of the fabric, traces of wax, scratches, color, and other features (Masiswo et al., 2017). Quality standards for hand-drawn batik are specified in SNI 8302 (2016), which outlines criteria for motifs, strokes, wax seepage, wax footprint, and other standardized parameters. Testing involves examining the resulting "klowong" lines, which serve as the framework for motifs, using a canting. Typically, batik is created on fine, soft, highly absorbent cotton fabric known as "mori prima," which ensures comfort and precise reproduction of motifs.

As the batik industry continues to grow, demand for batik is increasing among the public. However, the export of batik products experienced a decline between 2015 and 2020 (Dihni, 2021), and the domestic market demand has been affected by sluggish marketing, fabric and dye shortages. Moreover, small and medium enterprises (SMEs) have also experienced a significant impact from the COVID-19 pandemic. The economic downturn in Indonesia affects all industries, including the batik industry (Rachmawati et al., 2022). Despite this, batik holds promising prospects in the creative industry, capable of providing employment opportunities for millions. Various efforts have been made by multiple parties, including the government, for economic recovery post-pandemic (Noor, 2023; Sari, 2023).

The availability of primary fabric materials in batik production has improved in both quality and availability. Fabrics made from natural fibers, such as rayon, silk, and santung, are suitable for batik production, similar to mori prima fabric made from cotton fibers. Furthermore, the choice of fabric is closely related to its compatibility with natural and synthetic dyes. Alegbe and Uthman (2024) provide a comprehensive review of dye-fiber interactions, highlighting how fiber type affects dye uptake, fixation, and colorfastness. This perspective strengthens the rationale for analyzing fabric variations in batik making, where both wax adhesion and dye absorption are essential for product quality.

However, the batikan or batik results on various fabrics with reference to the application of SNI for hand-drawn batik are not yet known. Despite the inclusion of the appropriate temperature for the batik waxing process, there is still no specific standard. Thus, there are many differences in data and information regarding this temperature. Furthermore, technological advancements in batik production have somewhat affected the hand-dyeing process.

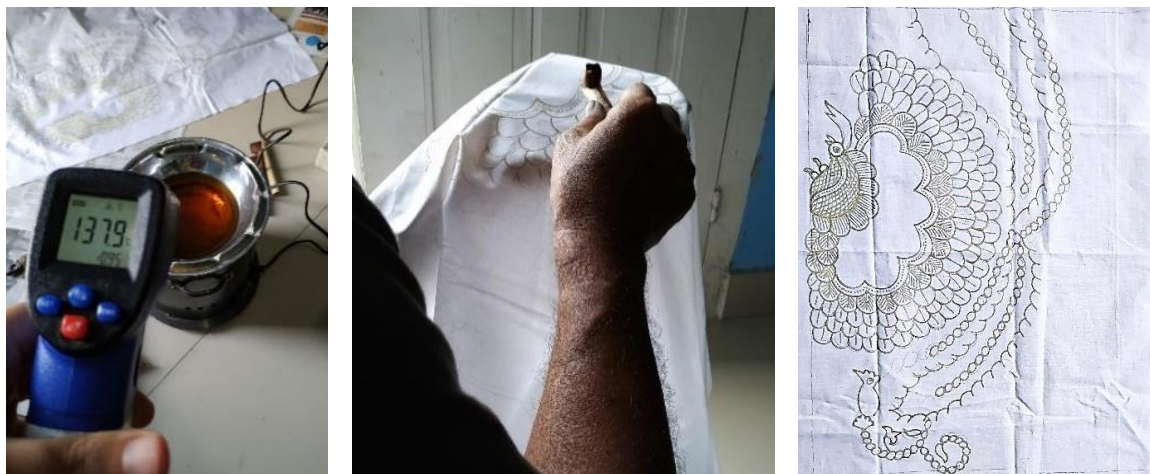


Figure 1. Batik Samples and Observation Locations

The process of melting batik wax is commonly performed using oil or gas stoves. However, the high price of kerosene and the availability of gasoline are often obstacles to SMEs in batik production. Electric stoves can serve as an alternative that reduces costs while improving work convenience (Clean Batik Initiative, 2011; Suparmanto, 2024). In addition to quality and production

efficiency, sustainability issues have become increasingly important in batik research. Previous studies on sustainable batik production have highlighted challenges, including high energy consumption during waxing, intensive water use in dyeing, and wastewater management that contains chemical residues from synthetic dyes. These findings emphasize the urgency of developing environmentally friendly alternatives and cleaner production technologies for the batik industry (Indarti et al., 2020; Sharmistha & Sinambela, 2023).

IKM Astoetik, which provides batik equipment and materials, offers a flagship product, electric batik stoves certified by SNI. Several series of batik stoves have been produced, including products with innovative features such as the SNI series A-SD003N batik stove integrated with the pan. However, it remains unclear whether these stoves can produce high-quality batik in accordance with the SNI standard for hand-drawn batik. In light of these issues, this study examines the effect of fabric type on batik results using the Astoetik electric batik stove.

Previous studies have highlighted the influence of fabric characteristics, temperature stability, and dyeing conditions on batik quality. However, limited attention has been given to the interaction between different fabric types and temperature-controlled electric batik stoves in determining wax penetration and overall batik quality (Rizal, 2025). Most existing studies, however, primarily focus on conventional batik production processes and traditional heating methods (Nursanti et al., 2023). Electric batik stoves have been developed as cleaner and more controllable heat sources that can maintain stable wax temperatures and improve working conditions (Syahputra & Soesanti, 2016). Although recent research has begun to evaluate the Astoetik electric batik stove across different fabric types, empirical evidence remains limited and further investigation is needed to understand fabric-specific responses and production outcomes (Rizal, 2025). Therefore, this study aims to extend existing knowledge by analyzing how different fabrics respond to batik production using an electric stove, thereby supporting innovation in sustainable and efficient batik manufacturing (Nursanti et al., 2023).

This study also contributes to vocational education by providing empirical insights into how different fabric types can be integrated into practical batik learning. The variation of fabrics enables students to directly observe the relationship between material characteristics, wax behavior, and dye absorption, thereby strengthening work-based learning practices that are in line with the Kampus Merdeka concept in vocational education (Kencana et al., 2022).

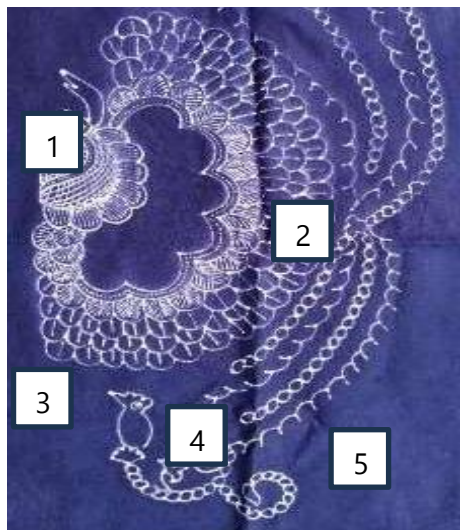
METHOD

This study employed a pre-experimental design using a one-shot case study approach. The design was selected because the research aimed to explore the influence of fabric type variations on the quality of hand-written batik produced using an electric batik stove. Although this design provides valuable preliminary evidence regarding batik quality across different fabric types, its limitations include the absence of repeated trials and control groups, which may restrict the generalizability of the findings. The study was conducted at the Astoetik SME workshop, where all batik samples were produced. Sample testing and image analysis were subsequently carried out at the Batik Laboratory of Universitas Negeri Yogyakarta and the Image Laboratory of the Department of Physics, Universitas Gadjah Mada.

The study involved two variables. The independent variable consisted of five fabric types commonly used in batik production, namely *mori prima* cotton, *mori primissima* cotton, rayon, silk, and *santung* fabrics. Each fabric sample measured 40x60 cm. The dependent variable was the quality of hand-written batik, which was assessed based on the visual characteristics specified in the Indonesian National Standard for hand-drawn batik (SNI 8302:2016).

Prior to the experiment, one sheet of each fabric type was prepared and marked with the classic Babon Angrem motif using a canting tool to ensure consistency across all samples. The batik production process followed conventional hand-drawn batik procedures, including pattern transfer, waxing, dyeing, and wax removal. The waxing process was performed using an Astoetik SNI electric batik stove (model A-SD003N) equipped with a batik pan. Additional equipment included a klowong canting, digital microscope, thermometer, electric roller, scissors, ruler, pencil, apron, and supporting work facilities. Batik wax and the selected fabrics served as the primary materials for the experiment.

All samples were produced under controlled conditions using the Astoetik electric batik stove at a constant temperature of 90°C, which has been identified in previous studies as an appropriate temperature for batik waxing. To evaluate the quality of the resulting batik, microscopic observations were conducted at five predetermined locations representing different motif characteristics. The first observation point measured the distance between *klowong* lines in the central ornament. The second focused on the diameter and area of the *isen cecek* motifs as well as the spacing between decorative points. The third examined the area of the *isen cacah gori* motif and the width of batik lines. The fourth measured the width of *isen sawut* lines, while the fifth assessed the dimensions of additional decorative ornaments. The observation locations are presented in Figure 2.



Description:

Location 1: Distance between *klowong* lines in the central ornament.

Location 2: Diameter or area of 2 batik motifs of *isen cecek* and the distance between points.

Location 3: Area of *isen cacah gori* and width of batik lines.

Location 4: Width of *isen sawut* batik lines.

Location 5: Area of additional ornaments.

Figure 2. Batik Samples and Observation Locations

Visual testing was conducted using a digital microscope by a team of at least five examiners with expertise in batik production. The assessment procedures followed the criteria outlined in SNI 8302:2016 for evaluating hand-drawn batik characteristics. Each sample was observed at the five designated locations, and five microscopic photographs were captured at each location. The images were subsequently processed using inverse thresholding techniques to improve visibility and facilitate accurate measurements. The resulting measurements were expressed in millimeters and interpreted by batik experts to relate quantitative findings to practical batik quality characteristics. Data collection was conducted through direct visual observation and digital image analysis. The testing process performed in the image laboratory is illustrated in Figure 3.

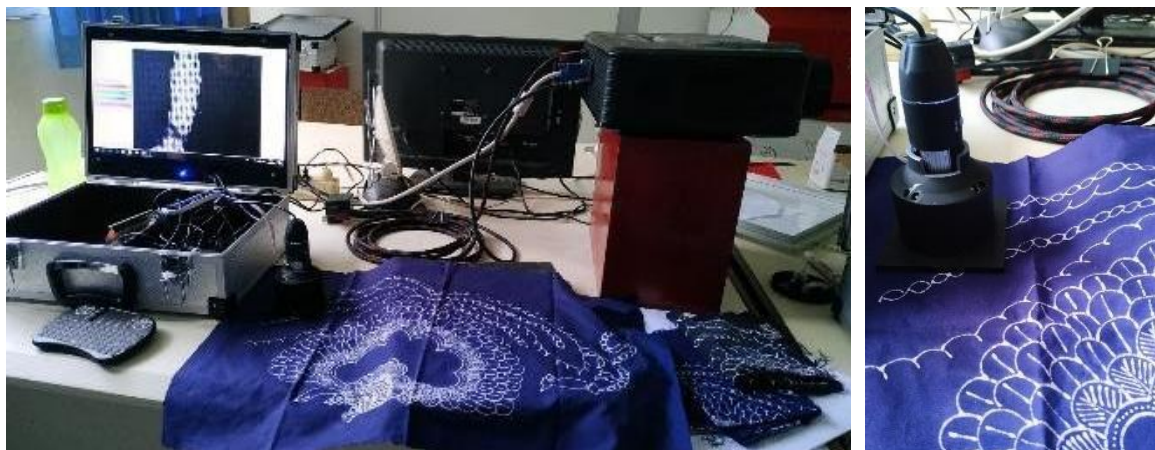

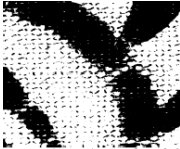



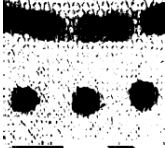
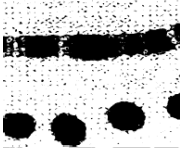
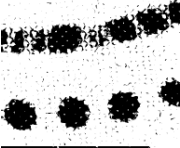








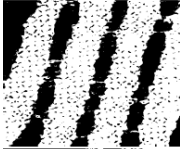


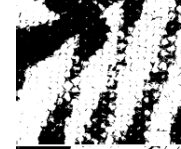

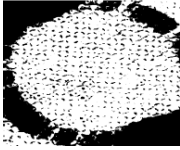

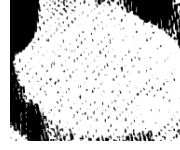
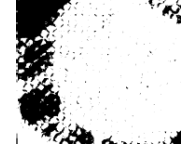


Figure 3. The Appearance of Testing Using a Digital Microscope

The processed microscopic images were compared across the five fabric types to identify differences in wax penetration, line characteristics, and motif dimensions. Representative examples of the threshold image analysis are presented in Table 1.

Table 1. Comparison of Microscopic Observation Threshold Images

No.	O1 - Prima	O2 - Prissima	O3 - Rayon	O4 - Silk	O5 - Shantung
1					
2					
3					
4					
5					

The collected data were analyzed using descriptive statistics to summarize the observed characteristics of each fabric type. To determine whether significant differences existed among the five fabric groups, inferential statistical analysis was performed using one-way analysis of variance (ANOVA) at a significance level of $\alpha = 0.05$. The results of the analysis were used to evaluate the effect of fabric type variation on the quality of hand-written batik produced using the Astoetik electric batik stove.

RESULTS AND DISCUSSION

Results

The purpose of this study was to examine how different fabric types influence the quality of hand-written batik produced using the Astoetik electric batik stove. To achieve this objective, microscopic observations were conducted to evaluate the characteristics of batik lines, wax penetration, and motif consistency across five fabric types, namely mori prima, mori prissima, rayon, silk, and santung fabrics. These characteristics are important indicators of hand-written batik quality because they reflect the interaction between fabric structure, wax behavior, and the stability of the batik-making process. The microscopic analysis also provides objective evidence regarding the extent to which different fabrics support the formation of clear motifs and conform to the quality criteria outlined in SNI 8302:2016. The results of the observations are presented through digital microscope images and quantitative measurements of motif dimensions, which are discussed in the following sections.

Figure 4 presents a representative microscopic image of the isen cacah gori motif captured using a digital microscope. The blue circles indicate the measured widths of the batik lines used for subsequent analysis. Visual observation shows variations in line width, line continuity, and color distribution within the motif. These characteristics reflect the natural variability of hand-written batik produced using a canting, where the manual application of wax may result in slight differences in stroke thickness and appearance. Microscopic observation was therefore employed to provide more objective measurements of batik line characteristics before comparisons among fabric types were conducted.

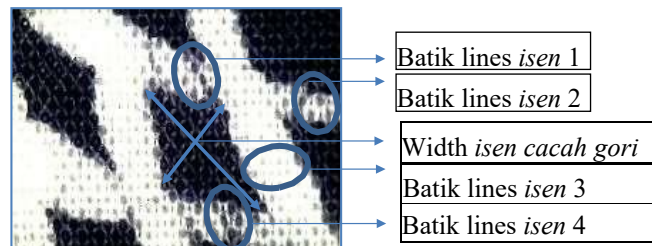


Figure 4. Location of Prima Fabric Samples on Cacah Gori Batik

Figure 5 presents the inverse-threshold image of the mori prima batik sample, which was generated to facilitate the observation of wax penetration, line continuity, and surface coverage. In the processed image, well-defined batik lines appear as continuous black regions, indicating effective wax application and adequate resistance to dye penetration. Conversely, white areas within the lines represent gaps, pores, or imperfections where wax coverage was incomplete. The image also reveals traces of color seepage and wax fragments, which are common characteristics of hand-written batik produced through manual canting techniques.

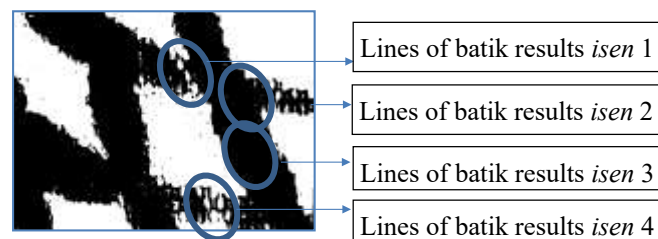


Figure 5. Inverse of Mori Prima Batik Result Samples

The batik results were analyzed at the same motif location to ensure consistency of comparison. In the isen 1 motif, the batik lines contain approximately four white spots resembling chain-like gaps. The isen 2 motif exhibits around six visible gaps, while the isen 4 motif contains more than six gaps along the observed lines. These variations indicate differences in wax distribution and penetration across the fabric surface. Despite the presence of several imperfections, the overall motif structure remained clearly visible, suggesting that the wax was generally able to cover the fabric surface according to the intended design. The occurrence of minor color seepage in several batik lines may be associated with variations in wax penetration, fabric absorbency, or the manual nature of the batik application process.

From a quality perspective, continuous and well-defined black lines indicate better motif clarity and stronger resistance to dye infiltration, which are important characteristics of high-quality hand-written batik. Therefore, microscopic observation provides valuable information regarding the interaction between fabric structure and wax behavior during the batik-making process. Quantitative comparisons of these characteristics across all fabric types are presented in Table 2.

The findings of this study have important implications. For vocational education, fabric variations can be used as practical learning materials, enabling students to understand the unique characteristics of different fabrics and their influence on batik quality. This not only enriches the

teaching of traditional crafts but also encourages innovation in the classroom. For industry and SMEs, the Astoetik electric batik stove offers potential benefits in energy efficiency, environmental performance, and cost-effectiveness relative to conventional stoves, making it suitable for sustainable batik production.

Table 2. Mean Width of Batik Results on Fabric

No.	Batik Results	Cecek	Cacah	Gori	Sawut	No.	Batik Results	Cecek	Cacah	Gori	Sawut
1	Mori Prima	0.893	1.204	0.570	4	Sutera	1.215	0.631	0.484		
		1.043	1.269	0.753			1.312	0.665	0.452		
		1.032	1.237	0.484			1.183	0.713	0.495		
		1.000	1.355	0.796			1.215	0.703	0.430		
			1.333					0.655			
	Mean	0.992	1.279	0.650		Mean	1.231	0.678	0.465		
2	Mori Primissima	0.892	1.290	0.570	5	Santung	0.301	1.032	0.581		
		1.097	1.323	0.570			0.645	0.935	0.452		
		1.011	1.258	0.581				1.075	0.774		
		0.946	1.108					1.000	0.796		
			1.032					1.043			
	Mean	0.986	1.202	0.573		Mean	0.473	1.030	0.650		
3	Rayon	1.043	1.032	0.828							
		1.022	0.978	0.871							
		1.011	0.763	0.903							
		0.871	0.720	0.806							
			1.000								
		1.032									
	Mean	0.986	0.920	0.852							

Discussion

The findings suggest that fabric characteristics play an important role in determining the quality of hand-written batik produced using an electric batik stove. Differences in fiber composition, weave density, thickness, and absorbency influence the way melted wax penetrates the fabric and subsequently affect dye absorption during the coloring process. Fabrics with tighter and more uniform structures, such as primissima cotton, tend to facilitate more consistent wax application and clearer motif formation. This observation is consistent with the opinions of batik experts, who identified primissima as the most suitable fabric for producing high-quality hand-written batik.

The results also indicate that the use of the Astoetik electric batik stove was capable of maintaining relatively stable wax conditions throughout the batik process. The predominance of line measurements within approximately ± 1 mm suggests that the wax temperature remained sufficiently stable to support consistent canting performance. Stable temperature control is important because excessive temperatures may cause wax to spread excessively, whereas insufficient temperatures may hinder wax penetration and reduce motif clarity. Therefore, the findings provide preliminary evidence that electric batik stoves can support the production of hand-written batik with quality characteristics comparable to those expected under conventional batik practices.

Another important finding concerns the relationship between fabric absorbency and coloration quality. Silk and santung fabrics were generally perceived by experts as producing stronger color intensity due to their higher affinity for dyes. However, these fabrics also present practical challenges during the batik process, including differences in texture, handling characteristics, and dimensional stability. In contrast, cotton-based fabrics such as prima and primissima offer a balance between wax penetration, motif clarity, ease of handling, and production efficiency, making them more suitable for educational and commercial batik production.

From a vocational education perspective, these findings demonstrate the importance of introducing fabric variation as part of practical batik learning. Students can directly observe how different fabric properties influence wax behavior, motif formation, and color absorption. Such learning experiences support competency-based and work-based learning approaches by linking

theoretical knowledge of textile materials with authentic batik production practices. Furthermore, the findings may serve as reference material for batik training programs and curriculum development in vocational fashion and textile education.

From an industrial perspective, the study provides practical information for batik artisans and SMEs regarding fabric selection when using electric batik stoves. Understanding the interaction between fabric characteristics and electric heating technology may help improve production consistency, reduce material waste, and support more sustainable batik manufacturing practices. This is particularly relevant as the batik industry continues to adopt cleaner and more energy-efficient production technologies.

Table 3. Batik Expert Opinions

No.	Batik Experts	Prima	Primissima	Rayon	Silk	Santung
1	Giriloyo (Bantul)	More capable of absorbing color than Primissima	Has a good <i>canting</i> effect	More absorbent of color	Easily absorbs resulting in denser hues	The fabric tends to stretch, washing it 2-3 times will cause it to expand, so it is rarely used for hand-drawn batik.
2	Taman Sari (Yogyakarta)	Generally produces good batik results and is commonly used for student batik practice.	Batik results have a good effect	Batik results are pretty good, with good coloring	Easily absorbs color	Batik results are pretty good, with good coloring.
3	Lendah (Kulon Progo)	Produces the best batik results below Primissima. More capable of absorbing color than Primissima	Produces the best batik results	Best batik results below Santung. Color absorption one level below Santung. The batik is of high quality because it is thinner.	Perfect for waxing and coloring	Good coloring, but the batik process is relatively complicated due to a thicker yet less perfect texture.

The findings of this study are consistent with previous research highlighting the importance of fabric characteristics in batik production. Earlier studies have shown that fabric structure, weave density, and absorbency influence liquid adsorption and spreading on textile surfaces, which can affect the interaction between wax, dyes, and textile fibers in batik production (Brnada et al., 2022; Riaz et al., 2023). The superior performance of primissima fabric observed in this study supports the view that fabrics with tighter and more uniform structures may facilitate better wax penetration control and more consistent motif formation, particularly when wax temperature and application conditions are controlled (Rizal, 2025). Similarly, the stronger coloration effects observed in silk and santung fabrics are in line with studies emphasizing the role of fiber properties and dye–fiber interactions in dye absorption, fixation, and color intensity (Hassan et al., 2024).

The present findings also contribute to the growing body of research on sustainable and technology-assisted batik production (Harsanto et al., 2026). Previous studies have highlighted the need for innovation in waxing processes, energy efficiency, and environmentally friendly production technologies within the batik industry (Nursanti et al., 2023). However, research specifically examining the interaction between fabric variation and electric batik stove technology remains limited (Indarti et al., 2020). Therefore, this study extends existing knowledge by providing empirical evidence that different fabric types respond differently under controlled electric heating conditions while maintaining acceptable batik quality characteristics. These findings support ongoing efforts to develop more efficient and sustainable batik production systems (Syakir et al., 2024) and provide practical insights for both vocational education and batik SMEs (Kencana et al., 2022).

However, this study also has several limitations. The number of fabric samples used is relatively small, and the absence of replication precludes a complete capture of variability across batik sessions. Moreover, this study did not compare results with non-electric stoves, which limits

the extent to which conclusions can be generalized to all batik production methods. These limitations should be addressed in future research to strengthen the robustness of the findings.

CONCLUSION

This study demonstrates that fabric type significantly influences the quality characteristics of hand-written batik produced using the Astoetik electric batik stove. Differences were observed in batik line width, wax penetration behavior, and coloration across the five fabric types examined. Primissima and prima fabrics produced the clearest and most consistent motifs, while silk exhibited stronger color intensity and finer line characteristics. Rayon and santung fabrics displayed distinctive responses related to their fiber structure and absorbency. Statistical analysis using one-way ANOVA confirmed significant differences among fabric types ($F = 156.189$, $\alpha = 0.05$), indicating that fabric characteristics play an important role in determining batik quality under controlled electric heating conditions. The findings contribute to the growing body of knowledge on technology-assisted and sustainable batik production by providing empirical evidence regarding the interaction between fabric characteristics and electric batik stove technology. The results suggest that electric batik stoves are capable of maintaining stable wax temperatures that support consistent motif formation while offering a potentially more energy-efficient alternative to conventional heating methods. From a vocational education perspective, the study highlights the value of incorporating different fabric types into batik learning activities, enabling students to directly observe the relationship between textile properties, wax behavior, and batik quality. For batik artisans and SMEs, the findings provide practical guidance for selecting appropriate fabrics to achieve desired quality outcomes and improve production efficiency. Despite these contributions, the study has several limitations, including the use of a one-shot experimental design, limited sample replication, and the absence of a comparison with conventional non-electric stoves. Therefore, future research should employ more rigorous experimental designs with larger sample sizes and repeated trials to improve the reliability and generalizability of the findings. Comparative studies involving electric, induction, and combustion-based stoves are also recommended to evaluate differences in temperature stability, energy consumption, production efficiency, and batik quality. Furthermore, future studies may explore a wider range of textile materials and dyeing conditions to support the development of more sustainable and innovative batik production systems.

REFERENCES

- Alegbe, E. O., & Uthman, T. O. (2024). RETRACTED: A review of history, properties, classification, applications and challenges of natural and synthetic dyes. *Heliyon*, *10*(13), e33646. <https://doi.org/10.1016/j.heliyon.2024.e33646>
- Badan Standardisasi Nasional. (2019). *Pedoman penerapan dan sertifikasi SNI produk batik*. Badan Standardisasi Nasional.
- Brnada, S., Pušić, T., Dekanić, T., & Kovačević, S. (2022). Impact of fabric construction on adsorption and spreading of liquid contaminations. *Materials*, *15*(6), 1998. <https://doi.org/10.3390/ma15061998>
- Clean Batik Initiative. (2011). *Panduan produksi ramah lingkungan bagi IKM batik*. Kementerian Perindustrian Republik Indonesia. https://lib.batik.go.id/index.php?p=show_detail&id=247&keywords=
- Dihni, V. A. (2021). *Nilai ekspor batik turun 31,3% pada 2020*. Databoks. <https://databoks.katadata.co.id/perdagangan/statistik/037fc3013ff3ef4/nilai-ekspor-batik-turun-313-pada-2020>
- Evita, Y. N., Trihartono, A., & Prabhawati, A. (2022). Pengakuan UNESCO atas batik sebagai Warisan Budaya Tak Benda (WBTB). *Majalah Ilmiah Dian Ilmu*, *21*(2), 113. <https://doi.org/10.37849/midi.v21i2.260>

- Febriani, R., Knippenberg, L., & Aarts, N. (2023). The making of a national icon: Narratives of batik in Indonesia. *Cogent Arts & Humanities*, 10(1), 2254042. <https://doi.org/10.1080/23311983.2023.2254042>
- Harsanto, B., Kasumaningrum, Y., Mulyana, A., Faisal, Y. A., & Hadjielias, E. (2026). Sustainable innovation in craft-based SMEs: a mixed-method study of Indonesian batik communities. *Small Business Economics*, 1–38. <https://doi.org/10.1007/s11187-026-01201-y>
- Hassan, M. N., Fariha, F. T., Zayee, Z., & Hasan, M. (2024). Analyzing different functional and dyeing performance of natural blended fabric utilizing natural dyes and quality prediction by fuzzy logic. *Heliyon*, 10(22), e40399. <https://doi.org/10.1016/j.heliyon.2024.e40399>
- Indarti, I., Rahayu, I. A. T., & Peng, L. H. (2020). Sustainable batik production: Review and research framework. *Proceedings of the International Conference on Research and Academic Community Services (ICRACOS 2019)*, 66–72. <https://doi.org/10.2991/icracos-19.2020.14>
- Kencana, M., Efi, A., Wakhinuddin, W., & Ambiyar, A. (2022). Model of work-based learning in accordance with the concept of Kampus Merdeka in vocational education. *International Journal of Health Sciences*, 6(S6), 5563–5574. <https://doi.org/10.53730/ijhs.v6nS6.10854>
- Mandegani, G. B., Setiawan, J., Haerudin, A., & Atika, V. (2018). Persepsi kualitas batik tulis. *Dinamika Kerajinan Dan Batik: Majalah Ilmiah*, 35(2), 75–84. <https://doi.org/10.22322/dkb.v35i2.4108>
- Masiswo, M., Setiawan, J., Atika, V., & Mandegani, G. B. (2017). Karakteristik fisik produk batik dan tiruan batik. *Dinamika Kerajinan Dan Batik: Majalah Ilmiah*, 34(2), 103–112. <https://doi.org/10.22322/dkb.v34i2.3439>
- Noor, A. F. (2023). *Sambut pemulihan ekonomi, Jokowi minta industri batik terus berinovasi*. *Republika*. <https://ekonomi.republika.co.id/berita/ryqw94490/sambut-pemulihan-ekonomi-jokowi-minta-industri-batik-terus-berinovasi>
- Nuriyanto, L. K. (2022). Preservation of the Batik industry in Indonesia as part of the national identity. *International Journal of Science and Applied Science: Conference Series*, 6(2), 1. <https://doi.org/10.20961/ijscs.v6i2.73912>
- Nursanti, I., McKay, A., & Chittenden, R. (2023). An Approach for the Assessment of Water Use in Batik Production Processes. In *IFIP International Conference on Product Lifecycle Management* (pp. 683–692). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-25182-5_66
- Rachmawati, R., Sawitri, S., Sawitri, S., & Prasetyaningtyas, W. (2022). Analisis pertumbuhan usaha UMKM batik di masa pandemi Covid 19. *Bookchapter Ekonomi Universitas Negeri Semarang*, 1, 54–72. <https://bookchapter.unnes.ac.id/index.php/ie/article/view/57>
- Riaz, M. T., Khan, M. I., Shaker, K., Nawab, Y., & Umair, M. (2023). Effect of cellulosic material and weave design on comfort performance of woven fabrics. *Journal of Natural Fibers*, 20(1), 2163030. <https://doi.org/10.1080/15440478.2022.2163030>
- Rizal, A. K. (2025). Optimizing the making of written batik on mori cloth automatically using programmed canting motion with temperature and feed-rate analysis. *Jurnal Polimesin*, 23(1), 128. <https://doi.org/10.30811/jpl.v23i1.5635>
- Rumiyati, R., & Oktyawati, D. (2020). Developing Kopaja.id as a fun online learning in general tax conditions topic. *Jurnal Pendidikan Vokasi*, 10(3), 282–289. <https://doi.org/10.21831/jpv.v10i3.36023>
- Sari, T. K. R. (2023). *Gerakan batik nusantara bangkitkan lagi industri warisan budaya pasca pandemi*. *Nova*. <https://nova.grid.id/read/053857240/gerakan-batik-nusantara-bangkitkan-lagi-industri-warisan-budaya-pasca-pandemi>

- Sharmistha, N. N. P., & Sinambela, F. C. (2023). Inovasi batik berbasis teknologi dan kinerja adaptif: membangun keberlanjutan industri batik. *Prosiding Seminar Nasional Industri Kerajinan Dan Batik*, 5(1), C–03. <https://proceeding.batik.go.id/index.php/SNBK/article/view/238>
- Suparmanto, N. (2024). Analisis kualitas kestabilan malam pada kompor batik listrik ber-SNI dan TKDN CV. Astoetik Indonesia. *Prosiding Seminar Nasional Industri Kerajinan Dan Batik*, 6(1), C–09. <https://proceeding.batik.go.id/index.php/SNBK/article/view/290>
- Syahputra, R., & Soesanti, I. (2016). Design of automatic electric batik stove for batik industry. *Journal of Theoretical & Applied Information Technology*, 87(1). <http://www.jatit.org/volumes/Vol87No1/18Vol87No1.pdf>
- Syakir, S., Sobandi, B., Rohidi, T. R., Syarif, M. I., Purnomo, M. A. J., Sukarman, B., Atmojo, W. T., & Hamdani, H. Y. (2024). Digital textile printing and batik preservation: A bibliometric analysis via VOSviewer. *Journal of Advanced Research in Applied Sciences and Engineering Technology*, 58(1), 181–203. <https://doi.org/10.37934/arasets.58.1.181203>
- UNESCO. (2009). *Indonesian Batik. Representative List of the Intangible Cultural Heritage of Humanity*. UNESCO. <https://ich.unesco.org/doc/src/06859-EN.pdf>