

Evaluation of Colour Fastness to Washing of Pineapple Fibre Fabric Treated with Traditional Malaysian Batik Dyeing Technique

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ABSTRACT

Pineapple fibre has emerged as a promising sustainable textile material due to its plant-based origin and potential application in fashion and textile products. However, the colour durability of pineapple fibre fabrics following traditional Malaysian batik treatment requires further investigation. This study evaluated the colour fastness to washing of two batik-treated pineapple fibre fabrics, namely Pina Cotton Batik and Pina Silk Batik. The fabrics were evaluated using the MS ISO 105-C03:1996 washing-fastness procedure, with colour change and staining assessed using standard grey scales following washing at 60°C for 30 minutes. The results showed that Pina Silk Batik obtained a colour-change rating of 3, compared with 2/3 for Pina Cotton Batik, indicating less visible colour change in the Pina Silk Batik sample. In contrast, Pina Cotton Batik achieved staining ratings of 3/4 on both cotton and silk adjacent fabrics, compared with 2/3 for Pina Silk Batik, indicating less visible colour transfer. The findings demonstrate that colour retention and staining behaviour may differ according to the fabric substrate used in batik treatment. However, the findings should be considered preliminary because one composite specimen was evaluated for each fabric type. Further research involving larger numbers of independent specimens, repeated washing cycles, and statistical analysis is recommended to establish the reproducibility and durability of the observed colour-fastness performance.

Keywords: Pineapple fibre; Malaysian Batik; Colour Fastness; Sustainable Textile; Washing Fastness

INTRODUCTION

The increasing demand for sustainable textile materials has encouraged the exploration of alternative fibres derived from renewable and agricultural resources. Pineapple leaf fibre is one such material that has received attention for its potential application in textile and fashion products. The fibre is obtained from pineapple leaves, which are generally regarded as agricultural residues, providing an opportunity to convert underutilised biomass into value-added textile materials. The development of pineapple fibre textiles is therefore relevant to ongoing efforts to promote more sustainable material practices within the textile and fashion industry.

The performance of an alternative textile fibre, however, is an important consideration in determining its suitability for practical applications. In addition to basic physical and mechanical properties, aesthetic and functional characteristics such as colour appearance, colour retention, and resistance to laundering are important for textile products. These properties become particularly relevant when the fibre is subjected to dyeing and finishing processes. The interaction between the fibre structure, dye, and treatment conditions can influence the resulting colour performance and durability of the fabric.

Batik is an important component of Malaysian textile heritage and is recognised for its distinctive decorative and resist-dyeing techniques. Traditional Malaysian batik involves the application of wax as a resist before dyeing, followed by processes such as colour fixation, washing, and drying. While conventional batik production has commonly been associated with established textile substrates, the application of traditional batik techniques to alternative sustainable fibres may provide opportunities to combine cultural heritage with contemporary material development. Pineapple fibre therefore presents potential as an alternative substrate for batik textile applications.

Nevertheless, the visual appearance of a dyed textile alone is insufficient to determine its suitability for use. The durability of colour during washing is an important performance characteristic because laundering is a common maintenance process for apparel and textile products. Colour fastness to washing refers to the ability of a coloured textile material to resist colour change and colour transfer when subjected to washing conditions. Poor washing fastness can result in colour fading and staining of adjacent textile materials, potentially affecting the appearance and serviceability of the finished product.

The evaluation of washing fastness is particularly relevant when traditional dyeing techniques are applied to pineapple fibre-based textiles. Differences in fibre composition and substrate characteristics may influence dye uptake, colour retention, and staining behaviour. In the present study, pineapple fibre fabrics incorporating cotton and silk substrates were treated using a traditional Malaysian batik dyeing technique. Their washing fastness was subsequently assessed based on colour change and staining using a standardised washing procedure.

The study addresses the need for experimental evidence on the colour performance of pineapple fibre-based batik textiles under laundering conditions. Although pineapple fibre has been investigated as a sustainable textile resource, comparatively limited attention has been given to its colour fastness performance following the application of traditional Malaysian batik techniques. Evaluating this property is important in determining whether such materials can be considered for further development in sustainable textile and fashion applications.

Therefore, this study aims to evaluate the colour fastness to washing of pineapple fibre fabrics treated using a traditional Malaysian batik dyeing technique. Specifically, the study examines colour change and staining behaviour following washing and compares the performance of pineapple fibre fabric incorporating cotton and silk substrates. The findings are expected to provide empirical evidence on the washing performance of batik-treated pineapple fibre textiles and support further development of sustainable textile materials that combine alternative fibre resources with Malaysian traditional textile practices.

MATERIALS AND METHODS

Materials and Samples

Two pineapple fibre-based batik fabrics were evaluated in this study: Pina Cotton Batik and Pina Silk Batik. The Pina Cotton Batik consisted of pineapple fibre fabric incorporating cotton, while the Pina Silk Batik consisted of pineapple fibre fabric incorporating silk. Cotton and silk adjacent fabrics were used in the composite specimens to assess staining following the washing treatment. A standard soap solution was prepared using 5 g of standard soap and 2 g of anhydrous sodium carbonate (Na_2CO_3) in 1 L of distilled water. Distilled water was used throughout the preparation of the washing solution. The specific fibre proportions, fabric construction, mass per unit area, and thickness were not recorded as part of the original experimental procedure and therefore are not reported in this study.

Batik Process

The fabrics were treated using a traditional Malaysian batik dyeing technique prior to the washing-fastness evaluation. However, detailed parameters of the original batik treatment, including dye concentration, wax application conditions, fixation conditions, and processing duration, were not systematically recorded during the original experiment. These parameters are therefore acknowledged as methodological limitations of the present study.

Preparation of Test Specimens

One composite specimen was prepared for each dyed fabric, namely Pina Cotton Batik and Pina Silk Batik. Each specimen was cut to a dimension of 10 cm × 4 cm. The dyed pineapple fibre fabric was stitched together with the specified adjacent fabrics, namely cotton and silk, to form a composite specimen for the washing fastness test. As the study was designed as a preliminary experimental comparison, one composite specimen was evaluated for each fabric type. Consequently, the study did not include replicate specimens, measures of variability, or statistical analysis.

Figure 1 Roaches Machine



The Roaches Machine was used to subject the composite fabric specimens to controlled washing conditions in accordance with the MS ISO 105-C03:1996 standard. The machine maintained the required washing temperature and duration to evaluate the colour change and staining behaviour of the batik-treated pineapple fibre fabrics.

Washing Fastness Test

The colour fastness to washing test was conducted in accordance with the MS ISO 105-C03:1996 standard method. A Roaches Machine was used to simulate the washing conditions. The prepared soap solution was heated to 60°C using a hot plate before the specimens were introduced into the test jars. The composite specimens were placed in the test jars containing the required volume of soap solution according to the liquor ratio of 1:50. The jars were subsequently placed in the Roaches Machine and subjected to washing for 30 minutes at a temperature of 60°C. Following the washing process, the specimens were removed from the jars, rinsed, and dried prior to evaluation. The washed specimens were then assessed for changes in colour and staining.

Evaluation of Colour Change and Staining

The colour fastness performance was evaluated using standard grey scales. The assessment considered two aspects of washing fastness: change in colour of the dyed specimen and staining of the adjacent fabrics. The colour change of each dyed specimen was compared against the grey scale to determine the degree of colour alteration following washing. Staining was evaluated by comparing the appearance of the adjacent cotton and silk fabrics before and after washing. The evaluation was conducted jointly by two assessors. The assessors examined the specimens together, discussed their observations, and reached a consensus on the final grade for each assessment. The results were expressed using a rating scale from 1 to 5, with appropriate intermediate ratings where applicable. The final grades were subsequently recorded and compared between Pina Cotton Batik and Pina Silk Batik.

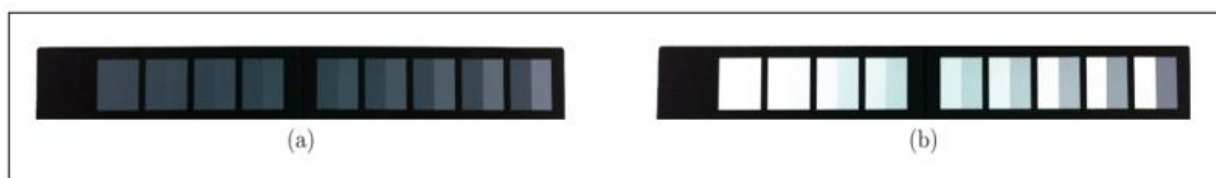
Colour fastness is an important quality characteristic of textile materials because it indicates the resistance of colour to various external agents encountered during textile processing, use, and care. Washing is one of the common factors that may influence colour retention and colour transfer in dyed textiles. Therefore, the assessment of colour fastness to washing provides an important indication of the durability of a dyed textile during laundering. Colour fastness is generally evaluated through two principal observations: change in colour and staining. Change in colour refers to the difference in appearance between the original dyed specimen and the specimen after exposure to a specified test condition. Staining refers to the transfer of colour from the tested specimen to an adjacent undyed material during the test. These two characteristics provide complementary information regarding the performance of a dyed textile. Visual assessment using standard grey scales remains an established approach for evaluating colour fastness. Kitaguchi, Kuramoto et al. (2012) examined instrumental

approaches for colour fastness assessment and compared instrumental measurements with visual assessments conducted by professional inspectors. Their study highlighted the continued relevance of visual evaluation and the importance of consistency in colour-fastness assessment.

The grey-scale system provides a standardised visual reference for assigning colour fastness grades. The scale ranges from 1 to 5, with intermediate grades available, where grade 5 represents the smallest perceptible change or staining and grade 1 represents the greatest change or staining. Separate grey scales are used for evaluating colour change and staining. This distinction is important because a dyed fabric may exhibit relatively low colour change while simultaneously producing a different degree of staining on adjacent fabrics. In textile research, standardised testing procedures are important for ensuring that colour fastness results can be evaluated consistently. The use of recognised washing and grey-scale assessment procedures therefore enables the performance of different textile substrates and dyeing treatments to be compared systematically.

Figure 2 Standard grey scales (a) for change in colour and (b) for staining

Source: Kitaguchi S.,Kuramoto K.,et al.(2012)



Results and Data Analysis

The colour fastness to washing results of the two batik-treated pineapple fibre fabric samples, namely Pina Cotton Batik and Pina Silk Batik, are presented in Table 1. The assessment was based on three parameters: change in colour of the dyed fabric, staining on the cotton adjacent fabric, and staining on the silk adjacent fabric. The results were obtained using the standard grey-scale assessment following the washing procedure.

Table 1 Colour Fastness to Washing of Pina Cotton Batik and Pina Silk Batik

Sample	Change in Colour	Staining	
		Cotton	Silk
Pina Cotton Batik	2/3	3/4	3/4
Pina Silk Batik	3	2/3	2/3

The results show that the Pina Cotton Batik sample recorded a colour change rating of 2/3, while the Pina Silk Batik sample recorded a higher rating of 3. Based on the grey-scale assessment, the difference indicates that the Pina Silk Batik sample exhibited less visible colour change following the washing treatment than the Pina Cotton Batik sample. For staining, Pina Cotton Batik recorded a rating of 3/4 on both cotton and silk adjacent fabrics. In comparison, Pina Silk Batik recorded a rating of 2/3 for both cotton and silk adjacent fabrics. The higher staining ratings obtained for Pina Cotton Batik indicate less visible colour transfer to the adjacent fabrics compared with Pina Silk Batik.

Overall, the results demonstrate different washing fastness characteristics between the two batik-treated pineapple fibre fabric samples. Pina Silk Batik showed a higher colour-change rating, whereas Pina Cotton Batik showed higher staining ratings on both adjacent fabrics. These findings indicate that the performance of a dyed textile under washing conditions may vary according to the fabric substrate and its interaction with the dyeing treatment. The results provide an initial experimental comparison of the washing fastness behaviour of pineapple fibre-based batik textiles. The findings are particularly relevant to the development of sustainable textile applications because colour retention and resistance to colour transfer are important considerations for the subsequent use and maintenance of dyed textile products.

Figure 3 Colour Change and Staining Assessment of Pina Cotton Batik After Washing.

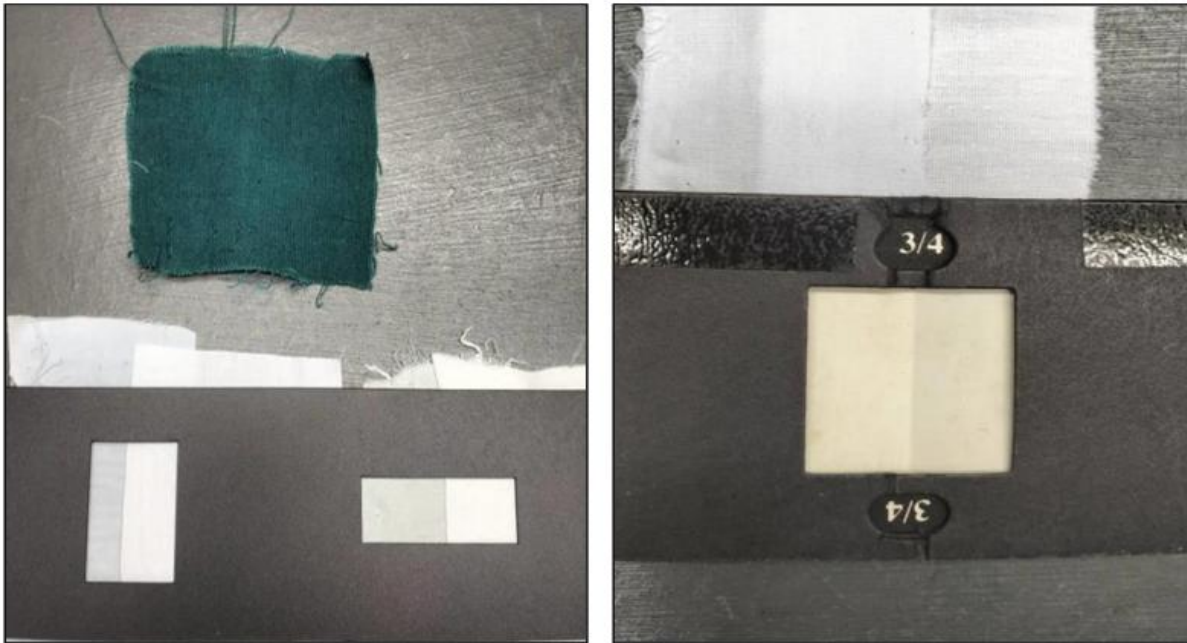
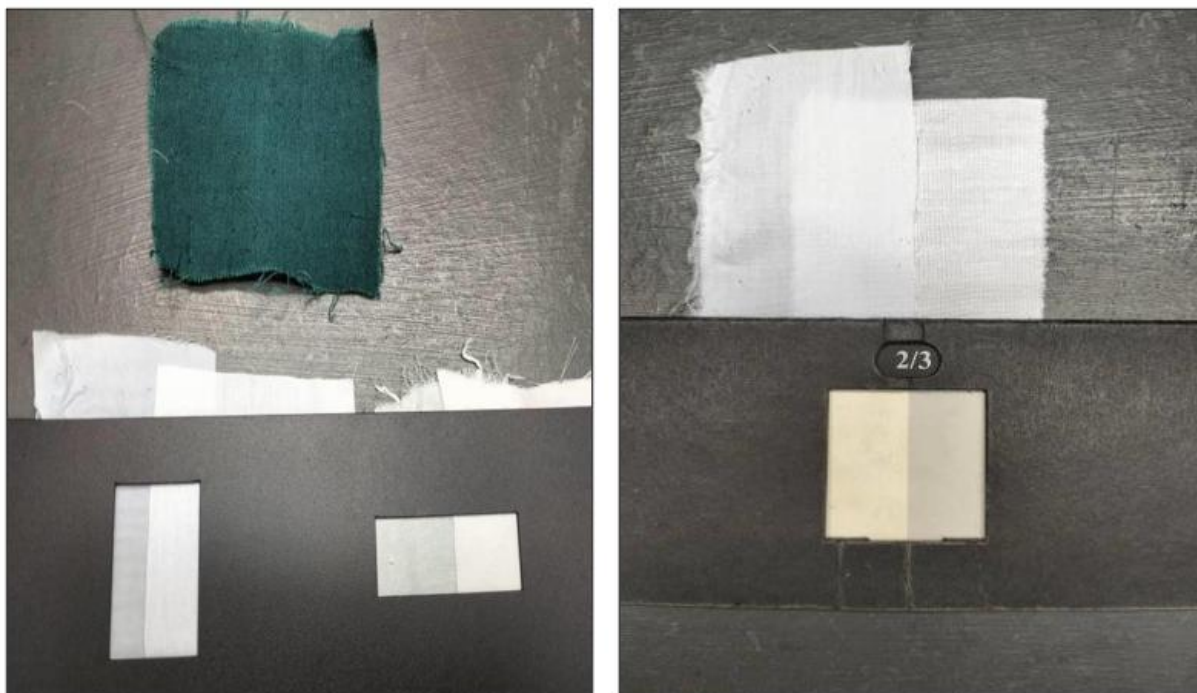


Figure 4 Colour change and staining ratings of Pina Silk Batik after washing.



Note: Higher grey-scale ratings indicate less colour change or staining.

RESULTS AND DISCUSSION

The findings were analysed to provide a clear comparison of the colour fastness to washing performance of the two batik-treated pineapple fibre fabrics. The analysis focused on colour change and staining of the adjacent fabrics following the washing treatment. The results were interpreted based on the grey-scale ratings obtained for Pina Cotton Batik and Pina Silk Batik, allowing differences in colour retention and colour transfer resistance between the two fabric types to be identified.

A limitation of the present study is the limited number of specimens evaluated. Only one composite specimen was prepared and tested for each fabric type. Therefore, the findings should be interpreted as preliminary

experimental observations and should not be generalised to represent the overall washing fastness performance of pineapple fibre fabrics. Future studies should employ multiple independent specimens for each fabric type, repeated washing cycles, and appropriate statistical analysis to establish the reproducibility, variability, and durability of the observed colour-fastness performance.

Result of Pina Silk Batik

The washing fastness assessment of Pina Silk Batik showed a colour change rating of 3 and a staining rating of 2/3. Figure 4 presents the visual assessment of staining after the washing treatment, where the observed contrast corresponded to a grey-scale rating of 2/3. This indicates a greater degree of colour transfer to the adjacent fabric compared with the Pina Cotton Batik sample, which recorded a staining rating of 3/4.

Result of Pina Cotton Batik

The Pina Cotton Batik sample recorded a colour change rating of 2/3, while the staining assessment produced a rating of 3/4. As shown in Figure 3, the visual contrast between the adjacent fabric before and after the washing treatment corresponded to a grey-scale rating of 3/4. Compared with Pina Silk Batik, the higher staining rating indicates less visible colour transfer to the adjacent fabric.

DISCUSSION AND COMPARISON

The results demonstrate different washing fastness characteristics between Pina Cotton Batik and Pina Silk Batik. Pina Silk Batik obtained a higher colour-change rating of 3 compared with 2/3 for Pina Cotton Batik, indicating less visible colour change following washing. In contrast, Pina Cotton Batik obtained higher staining ratings of 3/4 on both cotton and silk adjacent fabrics, compared with 2/3 for Pina Silk Batik. This indicates that Pina Cotton Batik exhibited less visible colour transfer to the adjacent fabrics, whereas Pina Silk Batik demonstrated comparatively better colour retention.

The difference in colour-change performance may be associated with differences in fibre composition and dye–fibre interactions within the batik-treated fabrics. The physical and chemical characteristics of a fibre can influence the uptake and retention of dye molecules. Research on pineapple leaf fibre has reported that dyeing performance and colour fastness are related to the interaction between the physical structure of the fibre and the dye (de Queiroz et al., 2019). Similarly, Rastogi et al. (2001) demonstrated that dye–fibre interactions can influence the fastness behaviour of dyes applied to silk and cotton.

In the present study, the higher colour-change rating obtained by Pina Silk Batik may indicate that the colourant was retained more effectively within the Pina Silk substrate during the washing treatment. This may be related to differences in dye uptake or dye–fibre affinity between the fabric substrates. However, this interpretation should be treated cautiously because the specific fibre proportions, dye chemistry, dye concentration, and fixation conditions used during the original batik treatment were not systematically recorded. Therefore, the observed difference in colour retention cannot be attributed to a single fibre or dyeing mechanism with certainty.

The staining results showed a different pattern. Pina Cotton Batik achieved staining ratings of 3/4 on both adjacent fabrics, whereas Pina Silk Batik recorded ratings of 2/3. The higher staining rating for Pina Cotton Batik indicates less visible colour transfer to the adjacent fabrics. This difference may be related to differences in dye uptake, dye–fibre affinity, and the degree of dye fixation within the fabric structure. When dye molecules are insufficiently retained within the fibre structure, they may be more readily released during washing and subsequently transferred to adjacent fabrics. Mohd Amin et al. (2021) reported that dyed pineapple leaf fibre exhibited measurable colour-change and staining performance during washing, demonstrating the relevance of dyeing conditions to the resulting colour-fastness behaviour.

The contrasting colour-change and staining results are important because these two parameters represent different aspects of washing fastness. Colour change reflects the visible alteration of the dyed fabric itself, whereas staining reflects the transfer of colour from the dyed fabric to adjacent materials. Consequently, a fabric may demonstrate comparatively better colour retention while showing greater staining, or vice versa. The present

findings illustrate this distinction: Pina Silk Batik showed better resistance to visible colour change, while Pina Cotton Batik showed better resistance to colour transfer.

The present findings are also relevant to previous research on pineapple fibre used as a batik medium. Azuan et al. (2022) documented the application of pineapple fibre fabric in Malaysian batik and highlighted its use as an alternative natural textile material for batik production. However, the present study extends this context by providing an experimental assessment of colour fastness to washing rather than focusing primarily on the use of pineapple fibre as a batik medium.

Overall, the results suggest that substrate composition may influence the washing behaviour of batik-treated pineapple fibre fabrics, particularly in terms of colour retention and colour transfer. However, the findings should be interpreted as preliminary observations because only one composite specimen was evaluated for each fabric type and the detailed parameters of the original batik dyeing treatment were not comprehensively documented. Further research using multiple independent specimens, controlled fibre compositions, clearly defined dyeing and fixation parameters, and repeated washing cycles is required to establish the relationship between fibre composition, dye–fibre interaction, colour retention, and staining behaviour.

CONCLUSION

The findings provide preliminary evidence of differences in colour change and staining behaviour between the two batik-treated pineapple fibre fabric types. Pina Silk Batik recorded a colour-change rating of 3, compared with 2/3 for Pina Cotton Batik, indicating less visible colour change following washing. In contrast, Pina Cotton Batik recorded staining ratings of 3/4 on both cotton and silk adjacent fabrics, while Pina Silk Batik recorded ratings of 2/3. These findings indicate that Pina Cotton Batik showed less visible colour transfer to the adjacent fabrics, whereas Pina Silk Batik demonstrated better colour retention following washing.

Overall, the findings demonstrate that colour change and staining may show different responses depending on the fabric substrate used in the batik treatment. Therefore, both parameters should be considered when assessing the washing performance of pineapple fibre-based batik textiles. However, the findings should be interpreted as preliminary observations because only one composite specimen was evaluated for each fabric type. Further research should involve a larger number of independent specimens, repeated washing cycles, and appropriate statistical analysis to establish the reproducibility, variability, and longer-term durability of the observed colour-fastness performance.

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REFERENCES

1. Kitaguchi, S., Kuramoto, K., Moridera, H., & Sato, T. (2012). Evaluation of instrumental methods for assessing colour fastness. *Journal of Fiber Bioengineering and Informatics*, 5(4), 399-409.
2. Azuan, M. F., Samin, M. A., & Legino, R. (2022). Natural fabric with pineapple fibres used as batik medium. *Environment-Behaviour Proceedings Journal*. <https://doi.org/10.21834/ebpj.v7iSI8.3923>
3. Collins, J. L. (1949). *The Pineapple: Botany, Cultivation and Utilization*. Leonard Hill, London.
4. Fletcher, K. (2014). *Sustainable Fashion and Textiles: Design Journeys* (2nd ed.). Routledge, London.
5. Gwilt, A. (2020). *A Practical Guide to Sustainable Fashion*. Bloomsbury Publishing, London.
6. Hakim, A., Sulaiman, N., & Rahman, M. A. (2017). Development of a semi-automatic wax removal machine for batik production. *International Journal of Engineering and Technology*, 9(4), 2850–2856.

7. Kusuma, R., Nugroho, A., & Hidayat, T. (2019). Augmented reality application for traditional batik motif transfer process. *International Journal of Interactive Mobile Technologies*, 13(7), 45–58.
8. Ministry of Agriculture Malaya. (1959). *Pineapple Cultivation in Malaya*. Government Printer, Kuala Lumpur.
9. Niinimäki, K. (2018). *Sustainable Fashion in a Circular Economy*. Aalto University, Helsinki.
10. R. M. N., & Fathima, M. S. (2018). Evaluation of colour fastness properties of lyocell and bamboo blended fabrics. *International Journal of Textile Science*, 7(2), 28–35.
11. Yusof, Y., Yahya, S. A., & Adam, A. (2015). Potential of pineapple leaf fibre in sustainable textile and composite industries. *Journal of Natural Fibers*, 12(6), 531–543.
12. Mohd Amin, A. N., Ruznan, W. S., Ahmad Suhaimi, S., Mohd Yusuf, J., Ab Kadir, M. I., & Mohd Nor, M. A. (2021). Washfastness properties of dyed pineapple leaf fibre using different dyeing techniques. *Journal of Academia*, 9(1), 66–72.
13. Rastogi, D., Sen, K., & Gulrajani, M. L. (2001). Photofading of reactive dyes on silk and cotton: Effect of dye–fibre interactions. *Coloration Technology*, 117(4), 193–198. <https://doi.org/10.1111/j.1478-4408.2001.tb00060>.
14. de Queiroz, R. S., da Silva, A. P. V., Broega, A. C. L., & Souto, A. P. G. V. (2020). New Brazilian pineapple leaf fibers for textile application: Cottonization and dyeing performance. *SN Applied Sciences*, 2, 72. <https://doi.org/10.1007/s42452-019-1855-8>