

# Investigating Moisture Vapour Transmission in Batik: Treated Pineapple Fibre Fabric Prior to Garment Development

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## ABSTRACT

The development of sustainable textile materials has increased interest in pineapple fibre as an alternative to conventional textile fibres. However, the application of batik techniques to pineapple fibre fabric may influence its moisture vapour transmission and suitability for garment development. This study investigates the moisture vapour transmission properties of pineapple fibre fabric treated with different batik techniques prior to garment development. The experiment evaluates the moisture vapour transmission performance of untreated pineapple fibre fabric and batik-treated samples to identify potential changes in fabric breathability and moisture transfer behaviour. The samples were prepared using selected batik application techniques and examined through laboratory-based testing. The findings are analysed to determine the relationship between batik treatment and the moisture vapour transmission characteristics of the fabric. The study also considers the implications of the findings for the development of comfortable and functional garments using pineapple fibre-based textiles. The results are expected to contribute to the understanding of pineapple fibre fabric performance and support the integration of traditional Malaysian batik techniques into sustainable fashion and textile product development.

**Key Words:** Pineapple fibre; Batik; Moisture vapour transmission; Sustainable textile; Textile performance; Breathability; Garment development

## INTRODUCTION

The growing demand for sustainable and environmentally responsible textile materials has encouraged researchers and designers to explore alternative fibres derived from renewable resources. Among these materials, pineapple fibre has gained attention due to its natural origin, potential biodegradability, and suitability for textile applications. Pineapple fibre is commonly obtained from pineapple leaf waste, providing an opportunity to transform agricultural by-products into value-added textile materials. This approach supports the development of sustainable fashion practices while reducing dependence on conventional textile fibres.

In Malaysia, batik is an important traditional textile craft that represents cultural identity, artistic expression, and local craftsmanship. Traditional batik techniques, including hand-drawn batik and block printing, involve the application of wax and dyes onto fabric surfaces to create decorative patterns. Although batik is commonly produced on cotton, silk, and other conventional textile materials, the application of batik techniques to pineapple fibre fabric presents opportunities for material innovation and the development of contemporary sustainable textiles. The application of wax, dye, and other treatment processes may influence the physical and functional properties of fabric. These treatments can alter the surface structure, thickness, weight, porosity, and moisture transfer behaviour of textile materials. One important property associated with clothing comfort is moisture vapour transmission. Moisture vapour transmission refers to the ability of a fabric to allow water vapour, such as perspiration vapour, to pass through its structure. Fabrics with suitable moisture vapour transmission properties may support improved breath ability and wearer comfort, particularly in warm and humid climates.

Despite the increasing interest in sustainable fibres and traditional textile innovation, limited attention has been given to the moisture vapour transmission performance of batik-treated pineapple fibre fabric. Understanding the effect of batik treatment on moisture vapour transmission is important before the material is developed into

garments. If the treatment significantly changes the fabric's ability to transfer moisture, it may influence the selection of garment design, construction techniques, lining materials, and end-use applications. Therefore, this study investigates the moisture vapour transmission properties of pineapple fibre fabric treated with selected batik techniques prior to garment development. The study compares the performance of untreated and batik-treated pineapple fibre fabric to identify differences in moisture vapour transmission behaviour. The findings are intended to provide useful information for textile designers, batik artisans, and fashion practitioners in developing sustainable garments that combine traditional Malaysian batik craftsmanship with innovative pineapple fibre-based materials.

## MATERIALS AND METHODS

This section describes the materials, experimental procedures, data collection methods, and data analysis employed to investigate the moisture vapour transmission and air permeability of Pina fibre fabric subjected to traditional batik processes, namely block and hand-drawn batik techniques. The methodology was structured to compare the moisture vapour transmission and air permeability performance of untreated pineapple fibre fabric with that of fabric subjected to traditional batik treatment processes.

### Materials Selection

Five pineapple fibre-based fabric samples were selected for this study to investigate their moisture vapour transmission and air permeability characteristics prior to garment development. The samples consisted of Pina Cotton Batik, Pina Silk Fibre, Pina Fibre, Pina Cotton Fibre, and Pina Silk Batik. The samples were labelled as Sample A, Sample B, Sample C, Sample D, and Sample E, respectively, to ensure systematic identification throughout the experimental process. The comparison of these samples was conducted to examine differences in moisture vapour transmission and air permeability performance among the selected pineapple fibre-based fabric.

Table 1.1 : Fibre Composition

| Sample | Fabric Sample     | Fibre Composition     | Batik Treatment  |
|--------|-------------------|-----------------------|------------------|
| A      | Pina-Silk Batik   | 70% Pina + 30% Silk   | Hand-Drawn Batik |
| B      | Pina Silk Fibre   | 70% Pina + 30% Silk   | Untreated        |
| C      | Pina Fibre        | 100% Pina             | Untreated        |
| D      | Pina Cotton Batik | 50% Pina + 50% Cotton | Block Batik      |
| E      | Pina Cotton       | 50% Pina + 50% Cotton | Untreated        |

The fibre composition and treatment conditions of each sample were recorded to ensure clear identification and consistency throughout the experimental testing and analysis.

### Fabric Sample Preparation.

The study was designed to compare the moisture vapour transmission and air permeability performance of untreated Pina fibre fabric and Pina fibre fabric treated using traditional batik block and hand-drawn techniques. This comparison aimed to determine the effects of the batik treatment on the fabric's breathability and moisture transfer properties.

### Batik Treatment Procedure

Two batik techniques were used in this study: hand-drawn batik and block printing batik. Sample A (Pina-Silk Batik) was treated using the hand-drawn batik technique, in which wax was applied to the fabric surface using a canting tool to create the selected motif. Sample D (Pina-Cotton Batik) was treated using the block printing

technique, in which wax was applied using a printing block. Samples B, C and E were not subjected to batik treatment and were used as untreated samples for comparison. After the batik treatment, the fabrics were prepared for laboratory testing to examine their moisture vapour transmission and air permeability.

### Moisture Vapour Transmission Test

The moisture vapour transmission test was conducted using a water vapour transmission testing apparatus to evaluate the moisture transfer characteristics of the selected Pina-based fabrics. A specimen was placed over a cup containing 50 mL of distilled water, with the exposed test area maintained at 0.0054113 m<sup>2</sup>. The specimen and cup assembly were weighed after 1 hour of testing and again after a total testing period of 5 hours. The difference between the two recorded weights was used to determine the amount of water vapour transmitted through the fabric. The elapsed time between the two measurements was 4 hours. The WVTR was calculated using the following equation:

$$WVTR = \frac{(W_b - W_a) \times 24}{t \times A}$$

where  $W_b$  is the weight recorded at 1 hour,  $W_a$  is the weight recorded at 5 hours,  $t$  is the elapsed testing time of 4 hours, and  $A$  is the exposed test area of 0.0054113 m<sup>2</sup>. The calculated WVTR values were expressed in g/m<sup>2</sup>/24 h.

### The air permeability Test

The air permeability of the selected Pina-based fabrics was evaluated according to ASTM D737-04/2008 using a MESDAN Air-Tronic air permeability tester. One fabric specimen measuring 150 mm × 150 mm was prepared for each sample. The test area was set at 5 cm<sup>2</sup> with a pressure differential of 100 Pa. The specimen was positioned between the flanges of the instrument, and the required test area and pressure settings were entered into the equipment before testing. Suction regulation was adjusted until the required pressure differential was achieved, after which the test was initiated. Two readings were recorded for each fabric sample and the average value was calculated for comparison. The air permeability results were used to evaluate the ability of the fabric structures to permit airflow through the materials.

### Data Collection/Results

The experimental data was collected from the moisture vapour transmission test conducted on the prepared fabric samples. The results were recorded according to the measurement unit and testing conditions provided by water vapour transmission testing apparatus. While for air permeability test conducted by using air permeability test machine. The collected data were then organised for comparison between the untreated and batik-treated fabric samples. The Water Vapour Transmission Rate was calculated using the following equation reported in this experiment.

The WVTR values were calculated using the equation described in Section 2.4. The calculated results were then organised for comparison among the five fabric samples and Air Permeability Test by using this formula: Average=R1+R2.

Table 1.2 Water Vapour Transmission of Pina Fibre Fabric Samples

| Sample | Fabric            | 1 Hour W <sub>b</sub> (g) | 5 Hour W <sub>a</sub> (g) | Mean (g) | Standard Deviation | WVTR (g/m <sup>2</sup> /24 h) |
|--------|-------------------|---------------------------|---------------------------|----------|--------------------|-------------------------------|
| A      | Pina-Silk Batik   | 114.7074                  | 113.2544                  | 113.9878 | 0.573504           | 1611.0731                     |
| B      | Pina-Silk         | 120.4642                  | 119.0950                  | 119.8004 | 0.538609           | 1518.1565                     |
| C      | Pina Fibre        | 119.4156                  | 118.0923                  | 118.7774 | 0.519435           | 1467.2629                     |
| D      | Pina-Cotton Batik | 119.9090                  | 118.4615                  | 119.2079 | 0.568762           | 1604.9748                     |

|   |             |          |          |          |          |           |
|---|-------------|----------|----------|----------|----------|-----------|
| E | Pina-Cotton | 119.8140 | 118.2251 | 119.0250 | 0.630206 | 1761.7578 |
|---|-------------|----------|----------|----------|----------|-----------|

Table 1.3 Air Permeability of Pina Fibre Fabric Samples

| Fabric Sample     | First Reading mm/s | Second Reading mm/s | Average Reading mm/s |
|-------------------|--------------------|---------------------|----------------------|
| Pina-Silk Batik   | 1609.0             | 1574.8              | 1591.9               |
| Pina Silk Fibre   | 2176.2             | 2176.8              | 2176.5               |
| Pina Fibre        | 562.4              | 554.0               | 558.2                |
| Pina Cotton Batik | 3623.1             | 3984.0              | 3803.55              |
| Pina Cotton       | 4016.0             | 4056.7              | 4036.35              |

## RESULTS AND DISCUSSION

The findings were presented in tables to enable a clear comparison between the five fabric samples. The analysis was used to compare the moisture vapour transmission and air permeability performance of the five fabric samples before proceeding to garment development. The data analysis provided a systematic comparison of the moisture transmission and air permeability characteristics of the pineapple fibre fabrics. The results were then interpreted in relation to fabric thickness, surface structure and potential comfort performance for clothing applications.

### Water Vapour Transmission

The analysis focused on comparing the performance of five fabric samples, identified as Sample A (Pina-Silk Batik), Sample B (Pina-Silk), Sample C (Pina Fibre), Sample D (Pina-Cotton Batik), and Sample E (Pina-Cotton). This sample identification was used consistently throughout the data analysis and interpretation of the experimental results.

The differences in water vapour transmission among the five samples may be related to the fibre composition of the fabrics. Bivainytė and Mikučionienė (2011) reported that the type of raw material has an important influence on the water vapour permeability of double-layered knitted fabrics, particularly due to the wetting and wicking characteristics of the fibres. In the present study, the Pina-Silk and Pina-Cotton fabrics showed different responses after batik treatment. The WVTR of Pina-Silk increased from 1518.157 g/m<sup>2</sup>/24 h for the untreated fabric to 1611.073 g/m<sup>2</sup>/24 h after batik treatment, whereas the Pina-Cotton fabric decreased from 1761.758 g/m<sup>2</sup>/24 h to 1604.975 g/m<sup>2</sup>/24 h after batik treatment. This difference suggests that the effect of batik treatment was not the same for the two fabric compositions. Fibre composition and the original fabric structure may have contributed to the different moisture transmission behaviour observed.

### Air Permeability Test

The air permeability results showed differences among the five Pina-based fabric samples. Pina-Cotton (Sample E) recorded the highest average air permeability value of 4036.35, followed by Pina-Cotton Batik (Sample D) with an average value of 3803.55. The reduction in air permeability after batik application suggests that the application of wax and colour may have altered the fabric surface and reduced the openness of the fabric structure.

The air permeability results also showed differences between the fabric compositions. Bivainytė and Mikučionienė (2011) found that fibre composition and fabric structure parameters influence the air permeability of knitted fabrics. They also reported that air permeability is related to the pore characteristics and finishing treatment of the fabric. A similar pattern was observed in the present study, where the untreated Pina-Silk recorded an average air permeability of 2176.5, which decreased to 1591.9 after batik treatment. For the Pina-

Cotton fabric, the value decreased from 4036.35 before treatment to 3803.55 after batik treatment. The reduction in both fabric groups suggests that the batik treatment may have affected the airflow through the fabric structure. However, the smaller reduction observed in the Pina-Cotton group compared with the Pina-Silk group indicates that the response may also depend on the original fabric structure and composition.

## CONCLUSION

This study examined the moisture vapour transmission and air permeability of five pineapple fibre-based fabric samples before garment development. The samples were identified as Sample A (Pina-Silk Batik), Sample B (Pina-Silk), Sample C (Pina Fibre), Sample D (Pina-Cotton Batik), and Sample E (Pina-Cotton).

The WVTR results showed different responses between the batik-treated and untreated fabrics. Pina-Silk Batik (Sample A) recorded a WVTR of 1611.073 g/m<sup>2</sup>/24 h, while Pina-Silk (Sample B) recorded 1518.157 g/m<sup>2</sup>/24 h. For the cotton-based fabrics, Pina-Cotton Batik (Sample D) recorded 1604.975 g/m<sup>2</sup>/24 h, compared with 1761.758 g/m<sup>2</sup>/24 h for Pina-Cotton (Sample E). Pina Fibre (Sample C) recorded the lowest WVTR value of 1467.263 g/m<sup>2</sup>/24 h.

A difference was also found in the air permeability results. Pina-Silk Batik (Sample A) recorded an average value of 1591.9, compared with 2176.5 for Pina-Silk (Sample B). Pina-Cotton Batik (Sample D) recorded 3803.55, while Pina-Cotton (Sample E) recorded 4036.35. Pina Fibre (Sample C) had the lowest average value of 558.2. In both fabric groups, the batik-treated samples recorded lower air permeability values than their untreated counterparts.

Overall, the results indicate that the type of fabric and the application of batik treatment can affect moisture vapour transmission and air permeability. The results can be used as a reference when selecting pineapple fibre-based fabrics for further garment development. Further testing with more specimens and additional fabric properties would help to provide a more complete understanding of their performance in clothing applications.

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