



Development of Bio-Finished Cotton Fabric Using Manilkara Zapota Latex for Antimicrobial Protection

¹N.Sangeetha, Assistant Professor, NIFT-TEA College of Knitwear Fashion, Tiruppur, Tamilnadu, India

²P.Prisha Shree, PG Diploma in Apparel Merchandising and Management, NIFT-TEA College of Knitwear Fashion, Tiruppur, Tamilnadu, India

Abstract

In the current pursuit of sustainable and eco-friendly alternatives for textile functionalization, natural plant-derived agents are gaining significant interest. This study explores the use of Manilkara zapota (sapota) latex extract as a natural antimicrobial finishing agent for 100% cotton woven fabric. Latex was extracted using conventional methods and applied to the fabric surface. The treated samples were evaluated for antimicrobial activity against *Staphylococcus aureus* ATCC 6538 and *Klebsiella pneumoniae* ATCC 4352 using the AATCC 147 (2016) qualitative method. The findings indicated that the treated fabric did not exhibit bacteriostatic zones, revealing no observable antimicrobial efficacy under the tested conditions. Despite the negative results, this study provides useful insights into the limitations and challenges of direct application of raw latex for textile finishing, highlighting the need for optimized extraction and formulation strategies.

Keywords: *Manilkara zapota, sapota latex, antimicrobial finish, cotton fabric, AATCC 147, natural textile treatment*

1. Introduction

In recent years, the textile industry has been shifting toward environmentally friendly and sustainable processes. One area of significant focus is the development of natural antimicrobial finishes to reduce odor, improve hygiene, and increase the longevity of textile products. Conventional antimicrobial agents often rely on synthetic chemicals that may pose environmental or health risks.

Manilkara zapota, commonly known as sapota or chikoo, belongs to the Sapotaceae family. Its latex contains a range of phytochemicals, including alkaloids, tannins, and polyphenols, which are believed to have antimicrobial potential. Although traditionally used in folk medicine, the application of its latex in

textile finishing remains largely unexplored. This study investigates the antimicrobial effectiveness of Manilkara zapota latex applied to cotton fabric as a natural finish.

2. Objectives

1. To extract bioactive compounds from Manilkara zapota latex using appropriate extraction methods.
2. To apply the extracted Manilkara zapota latex solution as a finish on 100% plain-woven cotton fabric.
3. To evaluate the antimicrobial efficacy of the treated cotton fabric.
4. To examine the effectiveness of the antimicrobial finish.
5. To analyze the physical and aesthetic properties of the finished fabric.

3. Methodology

The methodology adopted for this study involves four primary phases: extraction of latex from Manilkara zapota, preparation of cotton fabric, application of the latex as a finishing agent, and evaluation of antimicrobial activity using standard testing methods.

3.1 Extraction of Manilkara zapota Latex

Latex was manually collected from mature Manilkara zapota trees by making shallow incisions in the bark using sterilized tools. The exuded milky latex was collected in sterile glass containers early in the morning to minimize contamination and oxidation. The latex was filtered through a double-layered muslin cloth to remove debris and impurities.

No chemical solvents or preservatives were used to maintain the natural integrity of the latex. The filtered latex was stored in airtight containers at 4°C until further use. This crude form of latex was chosen to assess its natural antimicrobial potential in its most unprocessed state.

3.2 Preparation of Cotton Fabric

A plain-woven, 100% cotton fabric was used as the base material for the finishing treatment. The fabric was pre-treated through a scouring process to eliminate natural waxes, oils, and impurities that could hinder the absorption of the latex finish.

Scouring Process:

- The fabric was immersed in a solution of 2 g/L sodium carbonate and 2 g/L non-ionic detergent.
- Heated to 90°C for 60 minutes with constant agitation.
- Followed by thorough rinsing with distilled water and air drying at room temperature.

Pre-treatment ensured increased fabric wettability and uniform absorption of the latex during the finishing process.

3.3 Application of Latex Finish on Cotton Fabric

The finishing process was carried out using the **pad-dry-cure method**, a widely used approach in textile finishing.

Padding:

- The filtered latex was diluted to a 1:1 ratio with distilled water for ease of application.
- Cotton fabric samples (25 × 50 mm) were immersed in the latex solution for 5 minutes to ensure full saturation.
- Excess liquid was removed using a laboratory padding mangle set to a pressure ensuring 80–90% wet pick-up.

Drying:

- The padded fabrics were air-dried at room temperature for 24 hours to allow gradual evaporation of moisture.

Curing:

- The dried fabrics were cured in a hot air oven at 120°C for 5 minutes to facilitate binding of the latex to the fabric matrix.

After treatment, the fabric samples were conditioned at standard atmospheric conditions ($21 \pm 1^\circ\text{C}$, $65 \pm 2\%$ RH) for 24 hours before antimicrobial testing.

3.4 Antimicrobial Testing

The antimicrobial performance of the latex-treated cotton fabric was assessed using the AATCC 147 (2016) test method, also known as the Parallel Streak Method. This qualitative method evaluates antibacterial activity by observing bacterial growth inhibition zones.

Test Microorganisms:

- *Staphylococcus aureus* ATCC 6538 (Gram-positive)
- *Klebsiella pneumoniae* ATCC 4352 (Gram-negative)

Procedure:

- Nutrient agar plates were prepared and surface-inoculated with the bacterial cultures using parallel streaks.
- The treated cotton fabric swatches (25 × 50 mm) were aseptically placed over the streaks.
- Plates were incubated at 37°C for 24 hours.

Observation:

- Post incubation, the samples were examined for bacterial growth beneath and around the fabric.
- The presence or absence of a clear zone of inhibition (measured in mm) around the fabric indicated antimicrobial activity.

This method allowed a quick visual evaluation of the bacteriostatic effect of the latex-treated fabric.

4. Results and Discussion

Table 1: Antibacterial Evaluation (AATCC 147)

Test Organism	M2500091-1 Fabric: Woven Cotton Fabric	
	Bacteriostatic Activity (mm)	Growth Under Fabric
Staphylococcus aureus ATCC 6538	0	Present
Klebsiella pneumoniae ATCC 4352	0	Present
The sample showed absence of antibacterial activity against Staphylococcus aureus ATCC 6358 and Klebsiella pneumoniae ATCC 4352 when tested according to AATCC 147 2016 Method.		

The antimicrobial assay results showed no inhibition zones for either bacterial strain. Moreover, bacterial growth was observed beneath the fabric samples, indicating a lack of antimicrobial activity. These findings suggest that the unprocessed latex of Manilkara zapota may not be effective as a standalone antimicrobial finishing agent for textiles without further purification or chemical enhancement.

5. Conclusion

Although Manilkara zapota latex is known to contain bioactive compounds, its direct application on cotton fabric in this study did not exhibit any antimicrobial effect under standard laboratory conditions. Further research is required to isolate the active constituents, enhance their stability, and optimize the finishing process. Nonetheless, this work serves as an initial step toward integrating underutilized plant materials in sustainable textile functionalization.

6. References

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