Study of the effects of variables on textile analysis using FT-IR spectroscopy for forensic applications

Porntip Chaipraphan[1], Podsawat Bunfueang[2] and Kongkiat Trisuwan[1]*
Department of Chemistry, Faculty of Science, Chiang Mai University, Chiang Mai 50200, Thailand[1]
Police Forensic Science Center 8, Phunphin District, Suratthani 84130, Thailand [2]

I Abstract

This research evaluates the effects of contamination variables and laundering on the forensic analysis of cotton fibers using the FT-IR technique. Fresh pig blood roughened the fiber surface and produced amide peaks that lowered the Hit Quality but still allowed for fabric identification. Sauce left a sticky residue and broad O–H stretching peaks that obscured the cellulose structure, hindering accurate identification. Clay left dried residues and introduced mineral peaks that decreased Hit Quality without preventing identification. Burning significantly altered the spectral characteristics and made the fibers highly fragile. Additionally, black cotton fabrics showed lower %Transmittance due to higher infrared absorption. While laundering removed stains and improved spectral clarity, cleaning agents must be chosen carefully to avoid fiber damage. Overall, contaminant variables critically affect the reliability of FT-IR analysis, emphasizing the need for meticulous forensic evidence collection.

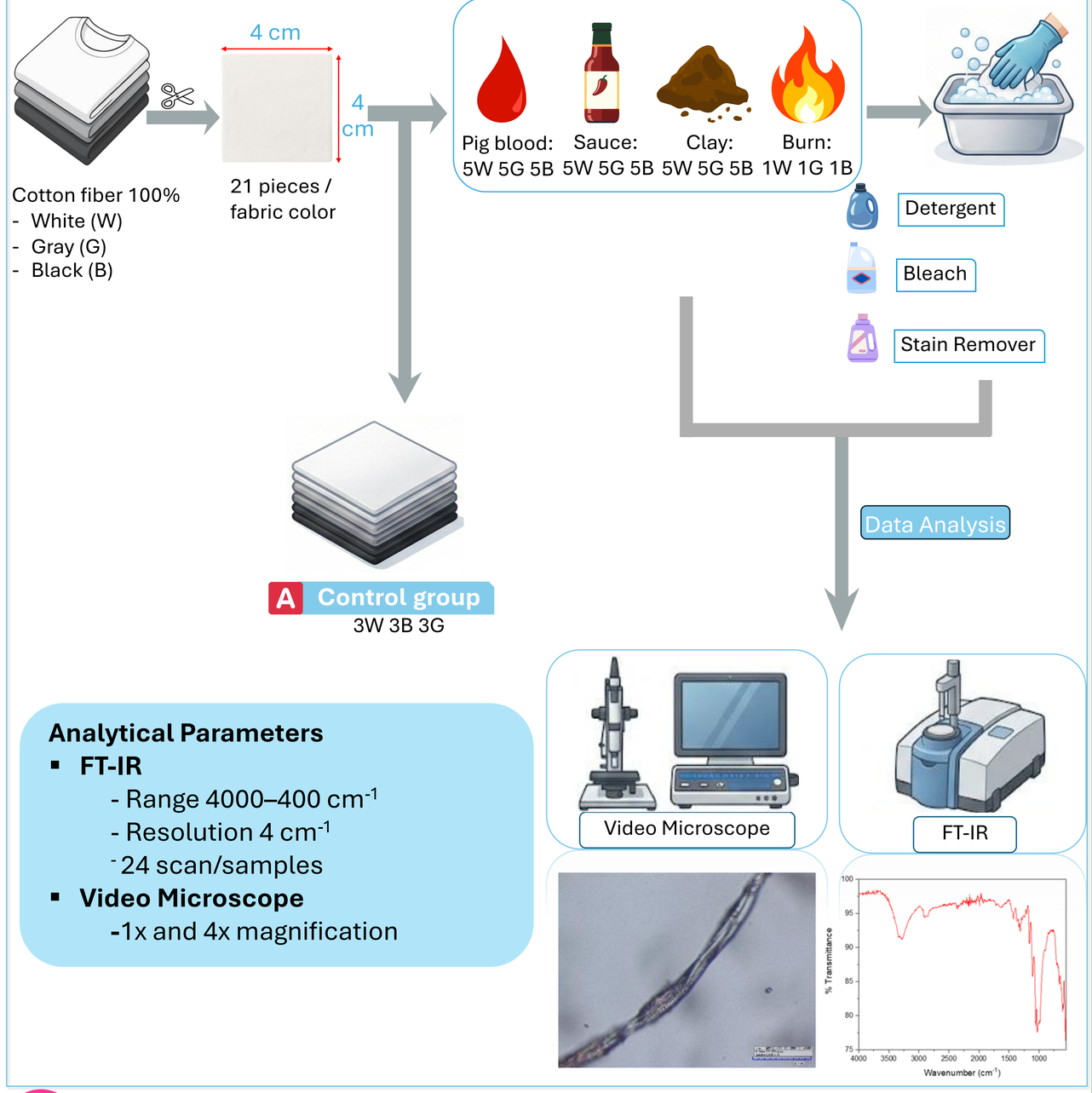
II Introduction

Textile fibers are crucial forensic evidence whose chemical structures can be analyzed using FT-IR, effectively linking suspects, victims, and crime scenes. However, in real-world scenarios, fibers are frequently contaminated by factors such as blood, clay, food stains, altered by laundering, or damaged by burning. Since each condition introduces distinct chemical properties, they can significantly interfere with analytical accuracy. Therefore, understanding the impact of these variables is vital for the correct interpretation and identification of fibers, ultimately enhancing the reliability of forensic examinations and supporting criminal investigations.

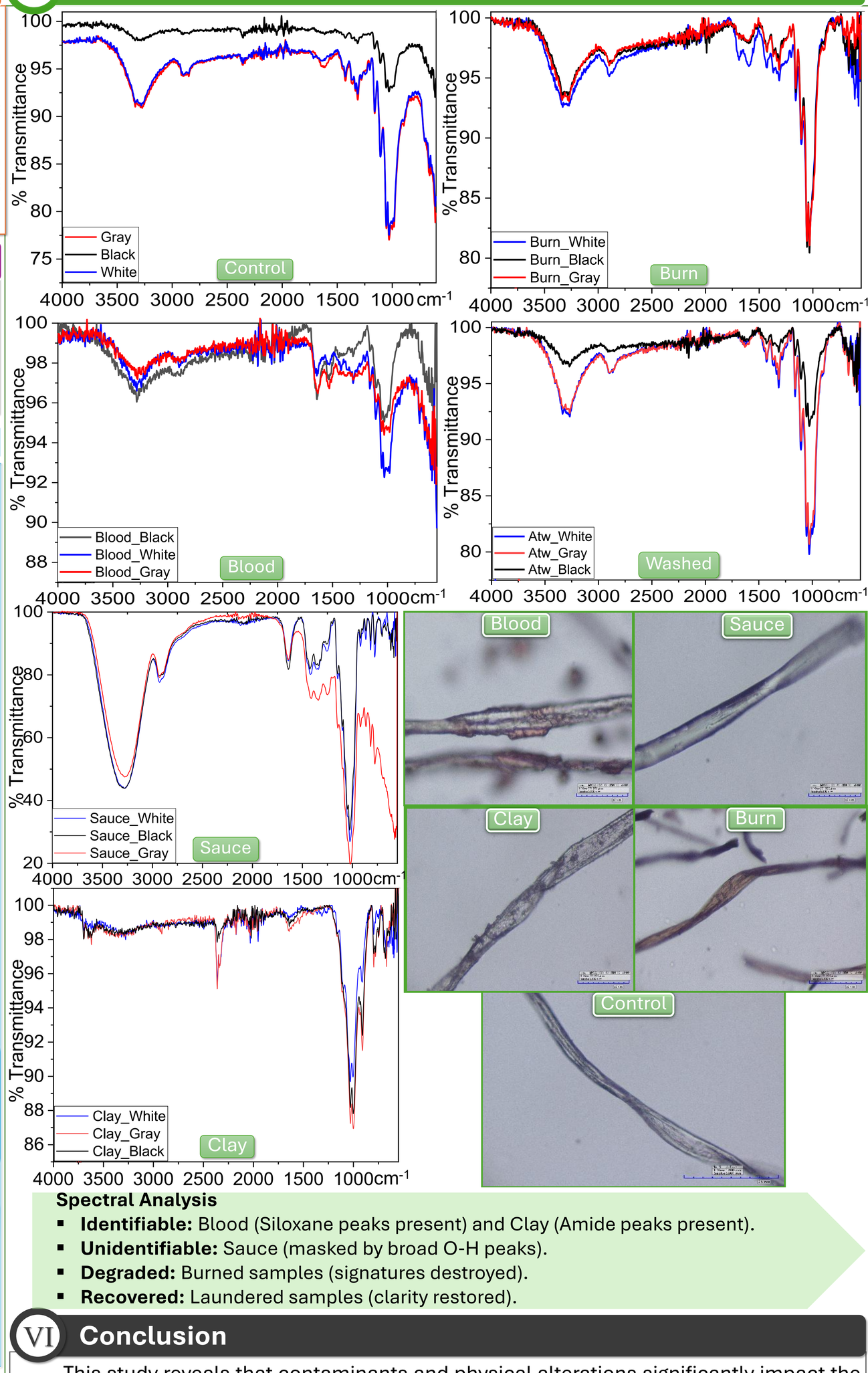
III Objectives

- To assess the physical and chemical changes in cotton fibers caused by specific variables, using FT-IR and video microscopy.
- To determine the effects of cleaning agents on the fibers' physical and chemical properties.

IV Experimental



V Results and Discussion



Spectral Analysis

- **Identifiable:** Blood (Siloxane peaks present) and Clay (Amide peaks present).
- **Unidentifiable:** Sauce (masked by broad O-H peaks).
- **Degraded:** Burned samples (signatures destroyed).
- **Recovered:** Laundered samples (clarity restored).

VI Conclusion

This study reveals that contaminants and physical alterations significantly impact the reliability of cotton fiber analysis via FT-IR. While blood and soil reduced the Hit Quality Index, fiber identification remained successful. In contrast, sauce severely hindered analysis by completely obscuring characteristic cellulose peaks. Burning physically degraded the fibers, causing extreme fragility and altering their chemical signatures. Although laundering improved spectral clarity by removing surface stains, it requires caution, as cleaning agents can introduce new residues or cause further damage. Ultimately, forensic experts must carefully account for a fiber's environmental history during evidence collection and spectral interpretation.

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