

COMPARATIVE EVALUATION OF CLEANING PRODUCTS FOR THE DETECTION OF LATENT BLOODSTAINS ON LAUNDERED FABRICS

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Structured Abstract

Background: Laundered bloodstains are challenging in forensic investigations due to reduced visibility and chemical alterations caused by cleaning agents, leading to unreliable UV and luminol results. This study compares UV light, luminol, and Fourier Transform Infrared Spectroscopy (FTIR) for detecting blood on cotton and polyester fabrics washed with various cleaning products. Detection methods were evaluated for sensitivity, specificity, and whether they were destructive. The goal is to determine the most effective detection technique and understand how fabric type and cleaning agents affect blood retention, aiming to improve forensic protocols and support more accurate, reliable evidence in criminal investigations.

Methods: 5 × 5 cm cotton and polyester fabrics, were stained with finger-pricked blood and left to dry. One unstained and one unwashed sample served as controls. The remaining samples were washed using four cleaning products 3 replicates of each by soaking in cleaning solution mixtures for 20 minutes, then air-dried. Blood detection was carried out with UV light at 360 nm in darkness and spraying with luminol for luminescence. ATR-FTIR analysis was conducted with spectra of 4000–650 cm⁻¹, resolution of 4 cm⁻¹, and 64 scans per sample. A total of three scans for each sample were taken, and spectra were read to identify functional groups.

Results: This study shows luminol detected blood on all samples, showing higher sensitivity than UV, which only showed weak or no reactions, especially on washed cotton fabrics. FTIR revealed that only Dynamo detergent completely removed key blood peaks (amide I & II), while Dettol, Kuat, and Lifebuoy left detectable residues. Polyester retained more blood signals post-wash than cotton, possibly due to fabric thickness. PCA confirmed distinct clustering of washed and unwashed samples, with Dynamo-treated fabrics clustering farthest from controls, showing effective cleaning. Residual detergent peaks overlapped with blood signals, highlighting the need to consider chemical interference during forensic analysis using FTIR and PCA.

Conclusion: This study concludes that FTIR, supported by PCA, is the most effective method for detecting laundered bloodstains. Dynamo showed the highest cleaning efficiency. Cotton retained blood better than polyester, highlighting the importance of fabric type and cleaning agent in forensic detection and evidence recovery strategies.

Keywords: Bloodstain Detection, FTIR Spectroscopy, Luminol, Fabric Types, Forensic Analysis.

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