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Forensic dating of blood stains: Integrated analysis by FTIR, pH and catalysis activity in different matrices

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Abstract

Background: The dating of blood stains represents one of the most relevant challenges in forensic science investigation. Estimating the time elapsed since the deposition of evidence can provide crucial information for reconstructing criminal events [1]. In recent years, spectroscopic techniques have emerged as promising tools for analyzing aged blood stains, with Fourier transform infrared spectroscopy with attenuated total reflectance (ATR-FTIR) standing out due to its speed, non-destructive nature, and ability to identify molecular changes over time [2, 3]. **Objective:** The present study investigates how different surfaces - wood, glass, 100% cotton tissues and metal - influence the biochemical evolution of blood stain aging for forensic dating purposes, using an analytical approach based on ATR-FTIR spectroscopy and complementary biochemical methods. **Methods:** Human blood samples (50 µL) were deposited on glass, metal, wood, and fabrics. ATR-FTIR spectroscopy, pH measurement, and catalase assays were used to monitor molecular and enzymatic changes over 30 days under controlled conditions. **Results:** Hemoglobin degradation and pH variations exhibited distinct trajectories between different surfaces, particularly on 100% cotton tissues. Substrates such as wood and fabric accelerated or altered oxidation patterns compared to glass and metal. **Conclusions:** The integration of spectroscopic and enzymatic techniques, added to pH and catalase activity studies, seem to be able to help in the development of surface-specific chronological models, increasing the precision of time-since-deposition estimates.

Keywords: blood stains; ATR-FTIR; catalysis; substrate effect; pH

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