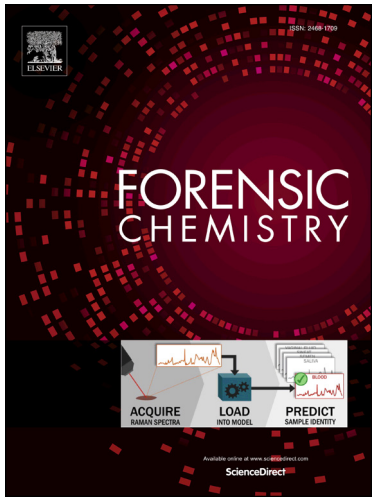

Full length articles

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Predicting the time of the crime: bloodstain aging estimation for up to two years

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Abstract

The chemistry of blood and the biomolecular changes that occur as a bloodstain ages are both inherently intricate, but can be monitored using specific analytical techniques. It has been shown that bloodstains are a rich source of information, which can be used to help in solving crimes. Particularly, the time since deposition (TSD) can be estimated by analyzing bloodstains and extracting information related to the natural chemical processes that occur as bloodstains age. This work summarizes a proof of concept study demonstrating the effectiveness of using Raman spectroscopy to nondestructively analyze bloodstains, and probe for specific kinetic changes in aged bloodstains for up to two years. As an initial step, bloodstains were identified as blood, and not a different body fluid, using a recently developed classification modeling technique. An overall success rate of 89% was demonstrated for predicting the identity of all stains as blood, with 100% correct blood identification for stains aged up to one month. The observed changes in the spectra over time were consistent with the known biochemical processes occurring as blood ages naturally, and those variations were sufficient enough to allow for differentiation and TSD predictions on the scale of hours to years. Specifically, TSD predictions were performed using partial least squares regression (PLSR) and principal component regression (PCR) analyses; where root mean squared errors of prediction of 0.29 and 0.31, respectively, were obtained. These errors correspond to an overall accuracy of ~70% for the models to correctly predict the TSD at each time point.

Keywords: Raman spectroscopy; Chemometrics; Serology; Time since deposition (TSD); Crime scene reconstruction; Trace evidence

1. Introduction

Blood is an extremely complex biological fluid that contains a plethora of useful information for medical, veterinary, and forensic purposes. Explicitly pertaining to forensic science, determining the time at which a crime occurred and the order of events of the crime scene can be challenging, especially if no reliable witnesses are available. However, certain disciplines of forensic science are used to provide clues, which can help in delineating these variables in the investigation. These branches include forensic pathology, forensic entomology, and forensic serology. Specifically, forensic pathology and entomology can provide information about the time at which a person died. A forensic pathologist can determine the post-mortem interval (PMI), which includes identifying the state of the body (i.e. algor mortis, livor mortis, or rigor mortis), for estimating how long a person has been dead [1]. Also, somewhat recently,