E86 Determining Donor Gender Based on Blood Stains Using Raman Spectroscopy

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After attending this presentation, attendees will better understand the recent advancement of this application of Raman spectroscopy. The implementation of advanced statistics for the analysis of spectroscopic data and the evaluation of the accuracy and reliability of the conclusions made will be discussed.

This presentation will impact the forensic science community by demonstrating the potential of the accuracy and effectiveness of biological stain analysis for forensic purposes.

Traces of body fluids discovered at a crime scene are a potential source of DNA, which is major individual evidence in the modern forensic investigation. The application of Raman spectroscopy for non-destructive, confirmatory identification of biological stains, including dry traces of sweat, vaginal fluid, semen, saliva, and blood, at a crime scene was recently reported.[1] This method allowed for differentiating animal and human blood as well menstrual and peripheral blood.[2,3] The theory behind Raman spectroscopy is based on the inelastic scattering of low-intensity, non-destructive laser light by a solid, liquid, or gas sample. Very little or no sample preparation is needed, and the required amount of material tested with a Raman microscope can be as low as several picograms or femtoliters. A typical Raman spectrum consists of several narrow bands and provides a unique vibrational signature of the material. Typically, non-resonance Raman spectroscopic measurements do not damage the sample. The stain could be tested the field and still be available for further use in the laboratory for DNA analysis. A portable Raman spectrometer is now a reality that should allow for this identification at the crime scene.

Men and women differ in many ways, including their chromosomal pattern, skeletal structure, and the average size of the stomach, kidneys, liver, appendix, and lungs. Women have three important physiological functions, which are totally absent in men, including menstruation, pregnancy, and lactation. These functions influence behavior and contribute to physical differences between men and women. It is most important for this study that the biochemical composition of blood is different for men and women. Women's blood contains 20% fewer red blood cells. A disparity in the coagulation factors and other proteins in plasma between the genders is well established. This study hypothesized that Raman spectra of blood might be sufficiently different between men and women so that a gender could be determined using this non-destructive analysis of a blood stain. Dry blood samples from a total of 60 donors were subjected to automatic Raman microscopic mapping followed by chemometrical analysis. Male and female blood spectral datasets were formed using MATLAB® 7.11 after preprocessing (baseline correction, noise reduction, and normalization by total area). Despite the fact that the average Raman spectra obtained for the two groups were similar, the unsupervised cluster analysis differentiated male and female blood samples satisfactorily. The most successful differentiation was achieved using the Support Vector Machine (SVM) algorithm followed by cross-validation by the sample-wise leave-one-out approach.

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Reference(s):

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Gender Determination, Blood, Raman Spectroscopy

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