E84 Race Differentiation by Raman Spectroscopy of a Bloodstain for Forensic Purposes

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The goals of this presentation are to illustrate: (1) the characteristics of current techniques applied for bloodstain analysis during forensic examination; (2) the importance of human phenotype profiling from body fluids found at a crime scene; (3) the significance of a non-destructive method for examination of trace evidence at a crime scene; (4) the advantages of Raman spectroscopy for crime scene examination; (5) Raman spectroscopy for body fluid analysis; and, (6) the application of advanced data analysis for distinguishing between human races based on bloodstains.

This presentation will impact the forensic science community by demonstrating how a non-destructive and rapid method is ideal for characterizing blood donors for forensic purposes. Gathering information about the donor can narrow the search during an investigation and can exclude irrelevant traces before a stain is subjected to DNA profiling. This study demonstrates the application of Raman spectroscopy, combined with chemometrics, for discriminating between Caucasian and African American blood donors.

Human blood is the most common body fluid found at scenes of violent crimes and it is an extremely valuable form of evidence in forensic investigations. The amount of sample available for an analysis could be extremely small. Therefore, proper handling and examination of an evidence is critical to preserve the trace for further examination. The ideal method for bloodstain analysis at a crime scene would be non-destructive, while providing a substantial amount of information about the sample.

In this study, Raman spectroscopy and advanced statistical analysis were applied to discriminate between Caucasian and African American donors based on dry traces of peripheral blood.[1] Samples from 20 donors varying in sex and age were used for collecting Raman spectra. This study utilized Genetic Algorithm (GA) analysis, which helped to select the spectral regions with the largest diversity between Caucasian and African American peripheral blood. For statistical analysis, Principal Component Analysis (PCA) was used to remove outliers. To discriminate between the two races, Support Vector Machines Discriminant Analysis (SVMDA) models were created. The internal Cross-Validation (CV) revealed 71% correct classification of donors based on all spectra included in a training data set. An outer loop subject-wise CV method was also performed and served to evaluate the performance of the SVM classifier for each individual donor from the training data set. The performance of SVMDA, evaluated by the Area Under the Curve (AUC) metric, revealed 71% probability of correct classification at spectrum level and 83% probability of correct classification at donor level for both races. A specificity and sensitivity of 80% was obtained. This proof-of-concept study demonstrated a great potential of Raman spectroscopy for determining a donor's race based on the bloodstain analysis. This method provides rapid and reliable results without any preparation, destruction, or consumption of the sample. The application of Raman spectroscopy at a crime scene is highly probable due to commercially available portable instruments. Furthermore, not only can a stain be identified as blood using this technology but, by incorporating statistical analysis, more information regarding the donor can be obtained, all in a reliable and statistically confident manner.

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Reference (s):

1. Mistek E., Halámková L., Doty K.C., Muro C.K., Lednev I.K. Race differentiation by Raman spectroscopy of a bloodstain for forensic purposes. *Anal Chem.* 2016:88(15):7453−56.

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