A137 Raman Spectroscopy as a Non-Destructive Technique to Differentiate Circulatory and Menstrual Blood

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After attending this presentation, attendees will have learned about the significance of Raman spectroscopy as a non-destructive technique in the differentiation of body fluids at a crime scene.

This presentation will impact the forensic science community by learning a more effective and rapid technique for body fluid identification at a crime scene. The development of portable handheld Raman instruments further allows the investigator to analyze samples in the field to obtain rapid results prior to collection of evidence.

The versatility and non-destructive nature of Raman spectroscopy has lead to its widespread use for rapid analyses in forensic science. The development of portable handheld Raman instruments further allows the investigator to analyze samples in the field to obtain rapid results prior to collection of evidence. Raman is already used to identify fibers, drugs, explosives, lipsticks, ink, paint, bones, fingerprints, and condom lubricants. The benefits of Raman spectroscopy, besides its main characteristic of being non-destructive, include reagent-free and minimal sample preparation, little interference from water, and a sample size as small as several picograms. In addition, results may be obtained through transparent packaging, thus allowing containment of potentially hazardous or biohazardous materials. Recent research has shown the potential for Raman spectroscopy to definitively and non-destructively identify and differentiate common body fluids including semen, saliva, vaginal fluid, sweat, and blood. Raman spectroscopy also has the potential to distinguish, non-destructively, human, canine, and feline species by their blood spectra using statistical analysis. Blood is the most common body fluid found at a crime scene and, in certain cases, the ability to distinguish menstrual blood from circulatory blood is desirable and may be critical. Current methods for identification of menstrual blood include the use of microscopy, lactate dehydrogenase isozyme identification, Messenger Ribonucleic Acid (mRNA) and Microribonucleic Acid (miRNA) profiling, real time-PCR, and identification of the products of fibrinolysis. These methods are complex, destructive, expensive, and have the potential for false negative results. Current methods for identification of circulatory blood are heme-catalyzed screening tests, which often involve a color change. These tests can be performed at the crime scene, but can have false positives and consume the sample. This research investigates the use of Raman spectroscopy as a tool to rapidly differentiate between circulatory and menstrual blood. Preliminary results have identified the main components of liquid and dried blood as well as investigated the spectra of blood on various substrates. Results show no difference in the spectra across genders and a time study of blood showed an increase in peak intensity of the component fibrin with time. The main components of liquid blood were hemoglobin, fibrin, glucose/L-tryptophan, and L-tryptophan/L-phenylalanine. The same main components were observed in dried blood. However, significant differences in peak patterns were present in liquid and dried blood due to coagulation, which included changes in peak morphology and an increase in peak intensity. The major physiological differences between menstrual blood are related to the ability of blood to clot and the presence of clotting agents, such as fibrin, in the blood. The ready detection of these agents in circulatory blood using Raman spectroscopy shows promise for its further use to identify menstrual blood. Menstrual blood has a non-clotting agent that breaks up clots and therefore affects the fibrin level present. In this study, menstrual blood was collected on gauze pads from female volunteers during two different menstrual periods. The same volunteers provided circulatory blood via a conventional blood draw. Differences in fibrin levels shown by Raman spectroscopy may be linked to the origin of the blood. Subtle differences in spectra were resolved using Chemometrics, specifically R, to show clear differentiation between menstrual and circulatory blood.

Raman, Blood, Fibrin

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