Review Article

Spectroscopy: An essential tool in biological evidence identification in forensics

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ABSTRACT

Forensic investigation is the gathering and analysis of crime-related evidence to find the suspect. Usually, in cases of sexual assault and child abuse, biological evidence like saliva, semen or vaginal fluid can be found.

And this biological evidence at the crime scene such as saliva stains, blood, urine, etc. can be detected using forensic light (spectroscopic technique) which is based on the natural character of absorption of light (blood) and fluorescence (saliva, urine, blood). Which can further be used for DNA fingerprinting This paper focuses on the advantages and limitations of various spectroscopic techniques.

Key Words: Spectroscopy; saliva; bodily fluids; Raman spectroscopy

INTRODUCTION:

Biological evidence like various bodily fluids present at the crime scene is a major source of DNA that further aids in-person identification. Various techniques have been developed for identifying these fluids which are further of two types presumptive and confirmatory. Most of the spectroscopic tests will destroy the DNA in the sample (1) These unfavorable drawbacks and limitations make necessary the exploration of additional analytical techniques to develop a novel methodology for the identification of these bodily fluids. The analytical spectroscopy seems more suitable for identifying the body fluids based on their characteristic spectral signatures. The spectroscopic technique is used frequently as it is a portable, simple, and cost-effective technique. It works along the visible and ultraviolet (UV-Vis) range. In addition, the application of more selective techniques, including near-infrared hyperspectral imaging (NIR-HSI), Fourier transform infrared (FTIR) and Raman spectroscopy, is being investigated. (2)

Spectroscopic techniques in forensics:

Most body fluids undergo fluorescence or absorption processes when they are irradiated by UV waves. This fact allows their rapid detection of small but also wide areas by using forensic lights. Since 1987 several authors have compared different UV-Vis lamps for body fluids detection. Auvdel (2,3) compared the detection of saliva, semen, and sweat stains, at different concentrations, on several clothes by using different UV-Vis lamps. However, results were not satisfactory because of the short UV-Vis range available within the UV-Vis lamps used. In the following year, the same author tested a UV-Vis lamp working along with a wider wavelength range and better results were achieved due to the increase of stains fluorescence (2,4) By using a wider range of UV-Vis wavelengths, Stoilovic, in 1991, achieved the detection of dried semen and bloodstains on photoluminescent and non-photo luminescent substrates, the optimum UV-Vis excitation wavelengths for each body fluid (skin oil, semen, blood, urine, and saliva) have been reported, proving that semen and urine seem to have a wider range of wavelengths in which they can be detected (5) Since then, UV-Vis lamps have been used in forensic laboratories worldwide for detecting stains of body fluids on different substrates. However, according to studies, (6-9) the selectivity provided by UV spectroscopy range is quite poor since the body fluids have a similar response within its range. Consequently, this technique does not enable the identification of body fluids (10). It also displays other limitations in the detection of body fluids, including the existence of several substances that respond as false positives and the interference of colored backgrounds from fabrics and other materials,

Vibrational spectroscopy an effective technique for body fluids identification.

The infrared range is particularly suitable for the forensic identification of body fluids because IR wavelengths are correlated with the chemical vibrations in molecules, which establish the characteristic bands observed in IR or Raman spectra. HSI, as well as other imaging techniques such as MIR thermal multimode imaging, seems to be highly suitable to detect stains of

body fluids since it combines the features from both photography and IR spectroscopy. This combination provides both spatial and spectral information of samples enabling the visualization of stains based on their characteristic spectra. However, most of the studies are exclusively focused on blood detection According to their different and characteristic spectra, the five body fluids were easily distinguished. Furthermore, they were differentiated from other substances. In the same way, Orphanou (11) focused on the discrimination between blood, saliva,

semen, and vaginal fluid by ATR-FTIR spectroscopy based on their different spectra. These spectra are. Also, the main chemical components of body fluids were also analyzed and those spectra were compared to body fluids. Briefly, human serum albumin and hemoglobin were tested for blood, Ŭ-amylase, and lysozyme for saliva, acid phosphatase (AP), prostate-specific antigen (PSA), and albumin for semen and AP, lysozyme and Ŭ-amylase for vaginal fluid.

Fluorescent spectroscopy to detect dried saliva stains from human skin

The authors conducted the study on ten volunteers who deposited their own saliva on the skin of their ventral forearm by licking. A control sample of water was deposited at the contralateral arm. Each sample was excited at 282 nm and the emission spectrum was recorded. The emission spectra of 10 swab samples taken from dried saliva were characterized at the primary peak of 345 to 355 nm whereas the emission spectrum of water as control was recorded at 362 nm. And the presence of emission spectrum at 345ï 355 nm with excitation at 282 nm proves to be a strong indicator of saliva deposited on human skin. (13), (14), (15) combined Raman spectroscopy and chemometrics offer a universal, single step, non-destructive, and robust technique with 100 % accuracy for sample identification based on external cross-validation.to build a statistical model that could differentiate peripheral blood, saliva, semen, sweat, and vaginal fluid. (16)

Conclusion:

Spectroscopy is promising in examining biological fluids, as its non-intrusive and less tedious. The UV-spectroscopy and fluorescent spectroscopy can be utilized as hypothetical or screening strategies, while FTR and Raman spectroscopy or IR spectroscopy is more precise than UV-spectroscopy and fluorescent spectroscopy as they are increasingly particular as it is related to the particular organic liquid.

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