B75 Capillary Electrophoresis/Mass Spectrometry for the Forensic Analysis of Dyes Extracted From Fibers

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After attending this presentation, attendees will be briefed on the use of capillary electrophoresis/mass spectrometry on textile fiber dyes.

This presentation will impact the forensic community and/or humanity by increasing discrimination between forensic fiber evidence

The goal of this presentation is to use capillary electrophoresis-mass spectrometry (CE-MS) for the analysis of dyes extracted from forensically relevant fiber samples to increase discrimination between evidence fibers.

Fiber evidence is frequently used in forensic science to associate a suspect to a victim or crime scene. The fibers are found as trace evidence in crimes of personal contact such as homicide, assault, sexual offenses, and hit-and-run accidents. In forensic fiber comparison, fibers are screened by visual inspection using optical microscopic techniques such as polarized light microscopy (PLM) and by spectroscopic methods such as UV-Vis and fluorescence microspectrophotometry. If spectra of the known and ques- tioned fibers are consistent, the hypothesis that the fibers originate from a common source should not be rejected. The premise of the current research is that additional discrimination may be achieved by extraction of the dye from the fiber, followed by trace analysis by a high resolution separation technique. A sensitive and selective technique such as capillary elec- trophoresis/mass spectrometry (CE/MS) is needed to analyze the small amount of dye (2-200 ng) present on forensically relevant fiber samples (2- 5mm). CE/MS can separate extracted dye components and provide semi- quantitative estimates of dye amounts as well as qualitative information to identify the dye present (via the molecular weight and mass spectra).

Three capillary electrophoresis methods have been developed for the direct separation and identification of extracted dye. The separation of acid, direct, reactive, and vat dyes, extracted from nylon and cotton fibers is per- formed using 5 mM ammonium acetate in acetonitrile-water (40:60, v/v), pH 8.7. Extracts from acrylic fibers containing cationic dyes can be ana- lyzed using 80 mM ammonium acetate buffer in acetonitrile-water (40:60, v/v), pH 5. Due to the insolubility of disperse dyes in water, a non-aqueous capillary electrophoresis (NACE) method with diode array detection (DAD) was developed for analysis of disperse dyes. This is also first report of CE analysis of disperse and vat dyes.

Extraction and subsequent analysis of dye components from fibers allows for enhanced discrimination of trace fiber evidence. A prototype decision tree for extraction of unknown dyes from textile fibers is presented. Three capillary electrophoresis methods with diode array detection (DAD) have been developed for the separation and identification of dyes from the six major textile dye classes. The separation of acid, direct, reactive, and vat dyes, extracted from cotton and nylon fibers, can be achieved using 5 mM ammonium acetate in acetonitrile-water (40:60, v/v), pH 8.7. Extracts from acrylic fibers containing cationic dyes can be ana- lyzed using 80 mM ammonium acetate buffer in acetonitrile-water (40:60, v/v), pH 5. Separation of hydrophobic disperse dyes can be completed using a non-aqueous CE method consisting of 80 mM ammonium acetate in acetonitrile-methanol (75:25, v/v), pH 7.5. CE-MS of small molecules has often employed sodium acetate or phosphate buffers with cationic sur- factants or cyclodextrins as buffer additives. However, because of the requirements of the electrospray ionization process, non-volatile buffers and buffer additives should be avoided in CE-MS system. CE-MS methods were developed and analyzed in positive ion mode for the analysis of basic dyes extracted from acrylics fibers.

Although this approach is destructive to the sample, automated micro- extractions offer the forensic analyst the potential of reproducible and com- plete removal of dyes from small quantities of a questioned fiber. The com- bined extraction CE-MS system is capable of achieving both highly dis- criminating and highly sensitive identification of fiber dyes. The subse- quent quantitation of the relative amounts of these extracted dyes may also provide enhanced discrimination of trace fiber evidence.

Discrimination of Fiber Dyes, Capillary Electrophoresis, Mass Spectrometry

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