A153 Forensic Discrimination of Red Hair Dyes by UV-Visible Microscpectrophotometry

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After attending this presentation, attendees will appreciate the value of cosmetic hair dyes in the analysis of human hairs and will learn how UV microspectrophotomerty is used in characterization of hair dyes.

This presentation will impact the forensic community by showing that hair dyes can be valuable evidence in the characterization of human hairs as evidence in crime scenes and how it can strengthen the association of hairs to individuals.

Human hairs occur in a wide variety of crimes, especially those involving violence. Hairs are easily shed and transferred from one surface to another. In recent years, DNA typing of the hair root and mitochondrial DNA typing of the hair body have added specificity to the analysis of hair and have provided a possible means of individualization in some cases. However, little attention has been paid to the analysis of cosmetic hair dyes that are often found in hair. The aim of this project is to successfully discriminate between hairs dyed with different commercial and professional red dyes using UV-Visible Microspectrophotometry, as well as to evaluate the proposed method as a viable approach to analyzing hair dyes as supplemental evidence in forensic hair examinations. The morphology and microscopic features of human hair provide a wealth of information such as species of origin, area of the body from which the hair originated, ethnicity, method of removal from the body, either forcible or naturally shed, in addition to disease states, thermal damage, and cosmetic modifications. Although cosmetic modifications occur with significant frequency, such as hair bleaching and/or dyeing, insufficient research has been performed in order to further distinguish and identify the products responsible for these modifications. In this project, a comprehensive set of fifty-five professional and consumer red hair dyes was analyzed with UV-Visible Microspectrophotometry and evaluated using multivariate statistical techniques including Agglomerative Hierarchical Clustering, Principal Component Analysis, and Linear Discriminant Analysis. The dyes were grouped into three classes, consistent with macroscopic visual inspection, yielding a classification accuracy of 81.45%. An external validation was performed by collecting new data for twenty of the dyes, resulting in a prediction accuracy of 76%. Three single-blind trials were also conducted, with two correct classifications and one inconclusive result. Temporal stability testing demonstrated consistent spectra throughout the duration of the study, spanning five weeks. Estimated fading of the dyes with successive washing indicated that significant color loss is apparent within three weeks of dye application. Finally, reduced classification accuracy was observed for calculated first derivative spectra relative to original data for a subset of fourteen professional hair dyes. The results showed that UV-visible microspectrophotometry can be a valuable technique in distinguishing among dyed hairs. It can provide useful, additional information about the association of hair with an individual beyond morphological examination.

Hair Analysis, Hair Dyes, Microspectrophotometry

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