B183 Barking Up the Wrong Tree: Detection and Identification of Illegally Traded Endangered Species of Wood Using Mass Spectral Techniques

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Learning Overview: The goals of this presentation are to introduce attendees to: (1) field-optimal sample collection for detecting and identifying illegally traded endangered species of wood; (2) classification of wood species using multivariate statistical analysis processing of mass spectral data; and (3) identification of diagnostic molecules for the identification of illegally traded wood species.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by providing information on a technique that enables law enforcement to distinguish and recognize endangered wood species in open spaces, such as shipping containers or at crime scenes.

Illegal logging and related trade occur when timber is harvested, transported, processed, bought, or sold in violation of national or sub-national laws. Globally, the act of illegal logging nets billions of dollars annually and accounts for 70% of all timber exports for some countries.[1] Organized crime networks in conjunction with corrupt government officials contribute to these sobering statistics. The illegally traded logs are difficult to distinguish visually from legally traded wood, and conventional identification techniques, including DNA profiling, morphological feature characterization, and stable isotope analysis, are time-consuming, costly, and require specialized expertise. These challenges make it more difficult for law enforcement to detect and identify illegally traded woods at points of entry into the United States. Therefore, a technique that is more readily amenable to field sampling is needed that will allow for the rapid detection and identification of illegally traded endangered woods. This study demonstrates that species-level identification can be achieved through the use of species-specific chemical signatures revealed by Direct Analysis in Real Time High Resolution Mass Spectrometry (DART®-HRMS) along with Gas Chromatography/Mass Spectrometry (GC/MS). The results demonstrate proof-of-concept that if a database of species-specific chemical signatures of endangered woods could be created, samples collected in the field can be screened against it to enable rapid species identification.

To develop the approach, multiple different species of wood representing a range of genera were shredded into a fine powder. The headspace volatiles of each were concentrated onto conditioned Solid Phase Microextraction (SPME) fibers for 30 minutes. The fibers were then analyzed using DART®-HRMS by suspending the fiber directly in the DART® gas stream for 30 seconds. The powdered woods were also analyzed directly by placing the closed end of a melting point capillary tube into the material, then suspending the coated surface of the tube in the DART® gas stream. The DART® mass spectra consistently showed inter-species differences and intra-species similarities and, therefore, the data were subjected to multivariate statistical analysis processing in order to perform classification. A set of feature masses were selected as species-specific diagnostic *m/z* values for each set of results, and these were used to perform kernel discriminant analysis. The statistical analysis processing showed that classification of wood species could be achieved from the chemical fingerprints produced from the direct analysis of the bulk material as well as the headspace of wood samples. In order to identify the molecules responsible for the ability to discriminate between species, the samples were analyzed using Thermal Desorption-Gas Chromatography/Mass Spectrometry (TD-GC/MS). The results revealed the identities of several *m/z* values whose presence was diagnostic of species, including 107.0492, 133.0663, and 137.0619 for the headspace samples and 255.1016, 285.1100, and 375.1097 for the bulk material samples. Tentative identification could be made in some cases and revealed the presence of benzaldehyde, cinnamaldehyde, and 4-methyoxybenzaldehyde in the headspace and dalbergichromene, 3,4-dimethyoxydalbergione, and caviunin in the bulk material. These results indicate proof-of-concept that the mass spectral analysis of wood samples can be used to create a database available to border patrol agents that can be used for the efficient identification of illegally traded wood species.

Reference(s):

1. Nellemann, C.; Henriksen, R.; Raxter, P.; Ash, N.; Mrema, E. *The Environmental Crime Crisis—Threats to Sustainable Development from Illegal Exploitation and Trade in Wildlife and Forest Resources*. United Nations Environmental Programme and GRID-Arendal, Nairobi and Arendal: 2014.

Endangered Wood, Species Identification, Mass Spectrometry

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