E24 Species-Level Forensic Identification of Illegally Traded Endangered Woods Using a Combination of Mass Spectral and Chemometric Techniques

Meghan Appley, MS, Ilion, NY 13357; Rabi A. Musah, PhD, State University of New York at Albany, Albany, NY 12222*

Learning Overview: The goal of this presentation is to introduce attendees to a rapid and efficient technique for the forensic identification of endangered species of woods. Current techniques are suboptimal for field analysis and attendees will be introduced to multiple mass spectral and chemometric techniques that can be used to resolve this issue.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by demonstrating a powerful new approach that will enable wildlife forensic science practitioners to effectively detect and identify illegally traded woods and combat illegal logging.

Wildlife trafficking is one of the most lucrative criminal enterprises in the world. It is international in scope and nets billions of dollars annually. One heavily traded wildlife commodity that occupies a large market share is illegal lumber. Illegal logging and related trade occur when timber is harvested, transported, processed, bought, or sold in violation of national or subnational laws. It is estimated that 70% of the timber exports of some countries is illegal. The revenue generated is often used to fund the illegal activities of organized crime networks and terrorism. Traditional techniques for wood species identification include DNA profiling, morphological feature characterization, and stable isotope analysis. These techniques are suboptimal for field analysis, such as at ports of entry into the United States, because of challenges, including their time-consuming and costly nature, and the requirement for specialized expertise to accomplish the identification. Therefore, a method is needed that would permit prompt detection and identification of illegally traded endangered woods. This study demonstrates that species-level identification can be accomplished through the use of species-specific chemical signatures revealed by Direct Analysis in Real Time-High Resolution Mass Spectrometry (DART®-HRMS), along with thermal desorption coupled with Gas Chromatography/Mass Spectrometry (GC/MS). These profiles can be subjected to multivariant statistical analysis processing to produce a screening device against which samples encountered by law enforcement agents can be compared for rapid identification of timber and wood products.

To develop this method, multiple samples of different species of wood representing a range of genera were cut into slivers and placed in scintillation vials. 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 placing the fiber directly in the DART® gas stream for thirty seconds. The wood slivers were also analyzed directly by suspending the wood slivers directly in the DART® gas stream. Both sets of results were subjected to multivariate statistical analysis processing, which revealed that chemical fingerprints could be generated from the direct analysis of the bulk material as well as the headspace of wood samples. Successful models for species-level identification of wood samples that featured the data acquired from the application of both techniques were created. Feature masses were selected for each of the data sets, then Kernel Discriminant Analysis (KDA) was used for the statistical analysis processing. The results showed clustering of like species in both of the models. Leave-One-Out Cross-Validation (LOOCV) was used to test the headspace analysis model and showed 97.14% accuracy. External validation was used to test the bulk analysis model and showed 87.50 % accuracy. To identify compounds associated with diagnostic molecular markers (i.e. *m/z* values), slivers of wood from each sample were placed in thermal desorption tubes and their headspace was then analyzed by GC/MS. The observed mass spectral fragmentation patterns not only enabled identification of several of the diagnostic molecular markers, but also revealed that the spectra exhibited interspecies differences and intraspecies similarities. The results from this study indicate proof-of-concept that the mass spectral analysis of wood samples, both headspace and direct, in conjunction with chemometric techniques, can be used to create a database that can be made available to law enforcement agents for the identification of illegally traded wood species.

Endangered Wood, Species Identification, Mass Spectrometry

*Presenting Author