B165 Identification of Triglycerides in Pristine and Degraded Vegetable Oils and Fats in Fire Debris Extracts by Liquid Chromatography/Mass Spectrometry

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After attending this presentation, attendees will understand a novel application of Liquid Chromatography/Mass Spectrometry (LC/MS) to the forensic analysis of vegetable oils and fats in fire debris samples.

This presentation will impact the forensic science community by presenting an LC/MS technique that will provide a method for directly identifying triglycerides in fire debris extracts without prior derivatization. Triglycerides are the principle components of vegetable oils and fats. Identification of triglycerides was found to be possible for vegetable oils and fats that had been used for cooking and/or exposed to fire conditions.

Triglycerides are the principle components of vegetable- and animal-based oils and fats. Analysis for triglyceride-based oils and fats provides valuable information in a range of fire investigation scenarios, including kitchen fires, household fire deaths, and cases of spontaneous combustion that involve oily rags.

As triglycerides are large molecules that are not sufficiently volatile to be analyzed directly by GC-MS, many laboratories derivatize triglycerides extracted from fire debris to their corresponding Fatty Acid Methyl Esters (FAMEs). FAMEs are readily separated and identified by GC/MS. In October 2013, the American Society for Testing and Materials (ASTM) International published a new standard test method for "Extraction and Derivatization of Vegetable Oils and Fats from Fire Debris and Liquid Samples with Analysis by Gas Chromatography/Mass Spectrometry" (ASTM E2881-13). Unfortunately, it is not possible to specifically confirm the presence of cooking oils and fats using this method as resulting FAMEs may originate from free fatty acids in the substrate and not from triglyceride-based oils and fats. The ASTM test method specifically cautions about forming this conclusion in section 4.2.1.

In order to confirm the presence of vegetable oils and fats, a method is needed that allows separation and identification of mixtures of intact triglycerides in fire debris extracts. Analysis of triglycerides by Liquid Chromatography-Mass Spectrometry (LC/MS) has been widely reported in food industry publications; however, these studies typically focus on pristine/unused cooking oils. In fire debris samples, cooking oils may be degraded by exposure to air, usage in cooking, and exposure to fire conditions. The purpose of this study was to determine whether or not mixtures of triglycerides could still be identified in fire debris extracts after the vegetable oils and fats had been used for cooking and/or exposed to fire conditions.

A total of 48 vegetable- and animal-based oils and fats were purchased at local supermarkets, including multiple brands of each type of oil or fat wherever possible. Each of these products was analyzed in their pristine state by LC/MS using Multiple Reaction Monitoring (MRM). Representative samples of each of these oils and fats were then placed in clean, unlined paint cans and heated with a Bunsen burner to their: (1) smoke point; (2) non-piloted ignition point; and, (3) self-extinguishment point. This was based on a method developed by the State of Florida Bureau of Forensic Fire and Explosives Analysis. Each of these burns was completed for neat liquids and liquids spiked onto cotton fabric or wood. Resulting residues were extracted with hexane and analyzed by LC/MS using MRM. Four oils with high smoke points (canola, peanut, soybean, and sunflower) were further subjected to six deep-fry cooking cycles using a commercial deep fryer. These cooked oils were subsequently analyzed by LC/MS to determine the effect of cooking. Cooked oils were then burned as per the method described above to determine the effect of fire conditions on oils that had previously been used for cooking.

Mixtures of four or more triglycerides were readily identified using LC/MS in all samples that had undergone cooking and/or burning. Differences in triglyceride peak ratios were minimal, and in many cases the degraded oil was indistinguishable from pristine/unused oils. In samples where peak ratio differences were observed, more degradation was observed on the more highly unsaturated triglycerides.

As mixtures of multiple triglycerides remained identifiable in all degraded samples in this study and the peak ratios of degraded samples were similar to pristine/unused oils, LC/MS analysis of triglycerides has been demonstrated to be an effective and reproducible method for the identification of cooking oil residues in fire debris extracts.

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