B197 An Analysis of Elemental Content in Various Brands of Cigarette Ash by Atomic Absorption Spectroscopy

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After attending this presentation, attendees will understand the value of elemental analysis of cigarette ash when cigarette butts yield no DNA profiles. Attendees will learn that atomic absorption spectroscopy, a less sensitive but less costly instrument, can provide results consistent with those obtained using inductively coupled plasma methods.

This presentation will impact the forensic science community by showing that the analysis of cigarette ash can provide additional information for use at a crime scene.

Very little work exists studying the ash produced by cigarettes to benefit forensic science. This study quantified element concentrations in cigarette ash to investigate the ability to distinguish American cigarettes through four comparisons: inter-brand, intra-brand, menthol/non-menthol, and pack. To obtain cigarette ash, a "smoking apparatus" including a vacuum pump was built to simulate smoking a cigarette. Approximately 100mg of ash was digested in 2mL of concentrated HNO_3 followed by the addition of 2mL of concentrated HCl. Trace metal grade standards were used to generate calibration curves with concentration ranges in parts per million (ppm) using a Buck Scientific® Accusys 211 Atomic Absorption Spectrophotometer (AAS). Three elements (potassium (K), calcium (Ca), and magnesium (Mg)) were chosen due to producing the highest intensity values when analyzed via scanning electron microscopy-energy dispersive spectroscopy. Zinc (Zn) was also chosen based on elements studied in previous similar studies. Using Linear Discriminant Analysis (LDA) and the four previously mentioned metals, comparisons of inter-brand, intra-brand, and menthol/non-menthol cigarettes were performed.

Within the inter-brand study, Parliament® (PM), Newport® (NP), Camel Blu® (CB), and Marlboro® Red (MMR) cigarettes were compared. When the concentrations of each element were plotted against one another, Mg compared to Ca provided the most distinct clustering of points. In an LDA plot, it was found that separation occurred between the clusters of PM, NP, and CB brands. This was consistent with a previous similar study utilizing inductively coupled plasma-atomic emission spectroscopy.[1] Although brand clustering was observed, the LDA model generated was not sufficient for complete discrimination.

In the intra-brand study, Marlboro® Green (MGr), Marlboro® Gold (MG), Marlboro® Blue (MB), Marlboro® Black (MBK), and Marlboro® Smooth (MS) were compared. Element plots showed that, when compared, Ca and K displayed the most clustering among the cigarette brands. This finding supports the results observed in another study comparing element concentrations in cigarette material.[2] In the LDA plot, there was more overlap observed between brands in the intra-brand study, which was expected; however, the LDA plot indicated that complete discrimination could not be achieved.

For the menthol/non-menthol comparisons, Ca plotted against K displayed the most separation between the two groups. In regard to the pack comparisons, a nested Analysis Of Variance (ANOVA) was performed to determine if the variance seen between packs of the same brand affect the variances observed between different brands. All four elements produced a significant effect on pack variance; however, variance between packs of brands was not enough to affect the variance between brands. Overall, Mg, Ca, and K provided the most information for comparison purposes. Although the results are consistent with previous studies, analyzing the composition of the cigarettes based on the four elements selected does not produce LDA models with the ability to discriminate between brands. The analysis of additional elements could potentially aid in doing so.

References:

1. Pérez-Bernal JL, Amigo JM, Fernández-Torres R, Bello MA, Callejón-Mochón M. Trace-metal distribution of cigarette ashes as marker of tobacco brands. *Forensic Sci Int* 2011; 204: 119-25.
2. Fresquez MR, Pappas RS, Watson CH. Establishment of toxic metal reference range in tobacco from US cigarettes. *J Anal Toxicol* 2013; 1-7.

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