Speciation and Statistical Analysis of Tobacco Smoke using Research and Selected Commercial Cigarettes

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Tobacco contains high concentrations of potentially toxic metals such as Pb and Sn. These metals can pose a significant health risk for people who smoke cigarettes or are exposed to the tobacco smoke. The toxicity, bioavailability, bioaccumulation, and potential for bioconversions of these metals are governed by the species of the metal (e.g., free metal or complexes). Speciation includes oxidation states, coordination numbers, and the type of ligands with which the metal is absorbed, adsorbed, or complexed. For example, both Pb and Sn can exist in more than one oxidation state, and so these species can be complexed by a variety of ligands including organic ligands. Therefore these metals can occur as organometallic complexes; these organometallic complexes may be bioavailable and thus potentially toxic.

The main objective of the study assessed the speciation of metals in the mainstream tobacco smoke. This study not only required the development of a method for detecting organo-metal complexes but also a method of quantifying the species of metal (total metal and complexed). The development of an analytical method for speciation of organo-metals involved the coupling of a gas chromatograph (GC) with an inductively coupled plasma mass spectrometer (ICP-MS). The GC separated compounds in complex matrices such as tobacco smoke based on their boiling point, polarity and molecular size. The ICP-MS provided quantitative metal concentration data. Our study established linear regression curves for four organotin standards in the GC-MS. The correlation coefficients (r^2) were between 0.9972 and 1.000 over a dynamic range of concentration from 0.2 to 1.0 mg/L.

In addition to quantification of organometals in tobacco smoke, a statistical study analyzed five of the top selling cigarette brands in the market for their nicotine content. Several brands studied in their different “flavors”-regular, light, filtered and unfiltered in order to study their different nicotine content. The correlation coefficient (r^2) for nicotine was found to be 1.000 over a dynamic range of concentration from 0.2 to 1.0 mg/L. There is a statistical difference between the five brands for the nicotine content.

Combining the different possibilities to explore speciation, will lead us to develop organo-metal standards based on the different analytical instruments used. Understanding of the relative abundances and species of metals in the main stream smoke will lend extraordinary insights into the toxicity of tobacco smoke and will provide much needed data in the study of smoking-related diseases. By establishing the chemical species of metals in tobacco smoke, the risks associated with inhalation of these compounds can be evaluated.