E1 A Method for the Determination of Canine Olfactory Limits of Detection (LoD) Using a Quantitative Vapor Delivery System

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Learning Overview: After attending this presentation, attendees will better understand the features and validation of the Trace Vapor Generator (TV-Gen), previously designed, fabricated, and validated by a multidisciplinary team of scientists at the Naval Research Laboratory, for the generation and delivery of reproducible and adjustable quantities of odor for canine testing.[1]

Impact on the Forensic Science Community: This presentation will impact the forensic science community by presenting a means to compare canine olfactory sensitivity to instrumental sensitivity.

The canine detector is one tool in an arsenal of commercially available chemical sensing instrumentation or sensors with diverse applications utilized by military, homeland security, and law enforcement. Canine sensitivity, meaning the ability to detect some minimum concentration of odor, is frequently reported as being lower than field detection instruments; however, there is minimal analytical information to support this claim. This presentation will discuss the development of a quantitative method of vapor delivery that will support research aimed at analytically assessing the LoD for canines.

The first attempt at canine LoD measurement was in 1953 by W. Neuhaus, where the threshold of canines for butyric acid was investigated. This study was designed to compare the olfaction systems of canines to humans. A controlled method of odor delivery was used, and canines were found to have a threshold of approximately eight logarithm (log) units lower than humans. However, further comparable studies showed great discrepancies when measuring canine LoD.[2] Although these and more recent studies were generally well designed and provided some necessary insight into canine LoD measurement, some issues with these testing methods were still apparent, yielding inconsistencies in reported measurements and large variations in threshold estimates. Odor delivery and sample introduction methods were thought to contribute to the discrepancies in LoD studies. For instance, the mentioned studies did not account for dilution of the odorant or loss of the odorant due to adsorption to transport materials. These are necessary parameters to consider because frequently when an odor is contained or passes through a material, such as tubing, a portion of the odor will adsorb onto the transport material and result in a lower vapor concentration. Additionally, once odor leaves the source, the vapor plume is diluted by the immediate air, lowering the concentration. Furthermore, it is difficult to control environmental variables. For example, surrounding air can carry the already dilute odor further away from the source, which would result in yet an even lower vapor concentration.

The objective of this presentation is to present an accurate, reproducible, and quantitative method for vapor delivery that will be utilized to measure canine LoD, as well as directly compare canine sensitivity to instrument sensitivity. Attendees will learn about the features and validation of the TV-Gen.

The TV-Gen was tailored to canine testing needs by including a custom canine sampling port and configuring appropriate sample vapor flow and temperatures. Computational fluid dynamics modeling was used to ensure even distribution of analyte vapor in the canine sample port. The generation and quantitation of three probative analytes—isoamyl acetate, 2,4-dinitrotoluene (a volatile component associated with Trinitrotoluene [TNT]), and methylbenzoate (volatile component associated with cocaine)—will be discussed, and the ability to easily adjust the vapor concentration of these analytes will be shown. Known and accurate concentrations of analyte vapors were generated, and the concentrations were decreased linearly by dilution of the aqueous solution or airflow stream. A carryover study also showed minimal-to-no-carryover of analyte in the sample port when switching from analyte to clean vapor streams. Follow-on work using these analytes at increasingly lower concentration will assess the response of canine detectors to determine their LoD.

Reference(s):

1. Giordano, B., L. DeGreeff, M. Hammond, M. Malito, C. Katilie, S. Rose-Pehrsson, and G. Collins. *Review of Scientific Instruments.* (in press).
2. Moulton, D. National Technical Information Service. *Talanta* 54, (2001): 487-500.

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