Use of an Electronic Nose to Evaluate Odors from Swine Operations

Susan S. Schiffman[1], Ricardo Gutierrez-Osuna[2], H. Troy Nagle[3]
[1]Duke University Medical School, [2]Wright State University, [3]North Carolina State University
[1]Durham, NC, [2]Dayton, OH, [3]Raleigh, NC

Livestock industries are expanding rapidly in many areas of the globe, and this expansion is causing environmental concerns. In swine operations, for example, odors emanate from confinement building ventilation air, waste storage and handling systems including lagoons, and field applications of waste. Anaerobic microbial decomposition of livestock waste appears to be the source of the more objectionable smells. Odorous compounds identified in livestock wastes include sulfides, volatile organic compounds, alcohols, aldehydes, amines, fixed gases, nitrogen heterocycles, mercaptans, carbonyls, and esters. Reduction of odors emanating from livestock operations is desirable to improve relationships between producers and their neighbors.

Sensitive measurement techniques are important for characterizing and documenting swine odors, as well as evaluating the effectiveness of methods for reducing odor. At present, olfactometry, in which a human odor panel evaluates the odors, is the most precise approach for quantifying odors since the nose can detect compounds at concentrations that cannot be detected by any other method. Human assessment, however, can be time-consuming and expensive. In addition, odor samples degrade rapidly so human panels must perform evaluations shortly after collection for accurate assessment. Since swine odor abatement research is being conducted all around the nation on a 24-hour basis, odor testing with human panels is often impractical. For this reason, it would be helpful to determine if an electronic nose with conducting-polymer or metal oxide sensors can substitute for human odor panels in evaluating methods for odor reduction.

A set of experiments was performed to evaluate and compare odors associated with swine production by both a human panel and an electronic nose. In the first experiment, detection threshold concentrations were determined for a major individual constituent in swine odor (i.e. acetic acid). Twelve serial dilutions of acetic acid that differed by a factor of 2 and ranged from 5% to 0.000028% v/v were presented to the human panel and the AromaScan A32 E-Nose for evaluation. The electronic nose signals were processed with the computer code described by Kermani (1996) and Gutierrez-Osuna (1998). The detection thresholds for acetic acid (dissolved in deodorized mineral oil) for both human and E-Nose methods were equal to 0.375% v/v.

In a second experiment, the effects of an odor remediation technology (a biofilter) were assessed for a single swine slurry component (isovaleric acid). The data were analyzed using Principal Components Analysis and Linear Discriminant Analysis which provided four discrete clusters (unfiltered isovaleric acid odor, filtered isovaleric acid odor, unfiltered room air, and filtered room air).

In a third experiment, five concentrations of the headspace above a synthetic swine odor sample (full strength – 1/1, as well as dilutions 1/3, 1/9, 1/27, and 1/81) were assessed by a human panel and the AromaScan A32S E-Nose and the NC State E-Nose. En-Nose and human intensity results were similar and suggested that that irritation intensity ratings by a human panel are a good measure of biofilter performance.

A final and fourth experiment compared human and E-Nose data using odorous samples collected in Tedlar bags® at a swine facility. Full concentration samples as well as 1/3 and 1/9 dilutions were collected before and after biofiltration. Again the human intensity data and E-Nose data were similar.

The main findings of this study are that the E-Nose could differentiate between different dilutions of the components of swine odor, between synthetic slurry, biofiltered slurry, and biofiltered blank/control samples, and between biofiltered and unfiltered air at a swine facility. Furthermore, the E-Nose data closely resembled intensity ratings from a human panel.

References

Gutierrez-Osuna R. 1998. Signal Processing and Pattern Recognition for an Electronic Nose. PhD Dissertation, Electrical and Computer Engineering, North Carolina State University.

Kermani, B. 1996. On Using Artificial Neural Networks and Genetic Algorithms to Optimize the Performance of an Electronic Nose. PhD Dissertation, Electrical and Computer Engineering, North Carolina State University.

Persaud KC, Khaffaf SM, Hobbs PJ, Sneath RW. 1996. Assessment of conducting polymer odour sensors for agricultural malodour measurements. Chemical Senses 21:495-505.