Assessment of Workers Exposure to Ammonia In Animal Facilities at Walter C. Todd Agricultural Research Center, Nacogdoches, Texas

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Abstract

Poultry, swine, and equine animal facilities are all considered as Concentrated Animal Feeding Operations (CAFOs). All these CAFOs are emission sources of gases and other pollutants which have negative impacts on the environment, human health, and animal health as well. One of those gases is Ammonia (NH_3), which is a colorless, highly irritating gas with a pungent, suffocating odor, and if inhaled in high concentrations, it may cause harm to the human body and the function of lungs. Personal exposure to ammonia was assessed for six workers in the three animal facilities: poultry, swine, and equine. Two workers from each facility wore passive badges (Model 584, Assay Technologies, OH) once per day over the sampling days. Eleven microenvironments frequented by the workers (stalls, barns, swine facility's rooms, broiler houses) were also monitored daily using color dosimeter tubes (Model 810-3DL, Gastec Corp., Japan). The concentrations in the microenvironments were read directly from the dosimeter tubes. An activity log was used to document the workers' activities and locations during their shifts. A Repeated Measures ANOVA statistical analysis was used to test for the differences among the personal-exposure concentrations.

Materials and Methods

Sampling

This research took place in three animal facilities: poultry, swine, and equine located at the Walter C. Todd Agricultural Research Center of Stephen F. Austin State University in Nacogdoches, TX and sampling was done for 10 working days, the last week of September and the first week of October in 2014. Two types of NH_3 sampling were conducted in this research: personal and aerial. The personal sampling aimed to measure how much each worker was exposed to NH_3 during the work shift while the aerial sampling aimed to measure how much NH_3 was suspended in the air indoor and outdoor of each facility.

Personal Exposure Sampling

- NH_3 personal passive monitoring badges which required lab analysis .
- Six workers, two in each facility.
- Chemical Analysis done in the lab.
- Duration of Exposure depended on the work shift.

A Worker at the Swine Facility Wearing the NH_3 Sampling Badge Monitor Attached to the Hobo Data Logger to Measure Temperature and Relative Humidity for Personal Exposure Sampling.

Aerial Exposure Sampling

- NH_3 passive sampler tubes that can show NH_3 concentration based on a change in the color inside the tube.
- Eleven sampler tubes distributed around the three facilities:

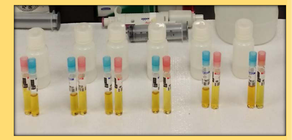
1. Poultry: four samplers inside each of the four chicken houses and one outside at the workshop.
2. Equine: one sampler in the barn area and one in the stalls area.
3. Swine: one sampler inside the farrowing, nursery, and the growing rooms, and one sampler outside the building.

Setting up a Colorimetric NH_3 Sampler Tube Inside One of the Chicken Houses for Aerial Exposure Sampling.

Chemical Analysis

All of the monitoring badges underwent chemical laboratory analysis in the lab daily after a sampling event ended. The filter (white disc) located inside each badge was submerged in a 20 ml NH_3 free deionized water for one hour to extract the NH_3 gas that was absorbed during the duration of exposure.

DR 3900 Benchtop Spectrophotometer with RFID* Technology that was used in the study to measure NH_3 concentrations. The spectrophotometer measures the amount of light of a specified wavelength which passes through a medium. According to Beer's law, the amount of light absorbed by a medium is proportional to the concentration of the absorbing material or solute present.

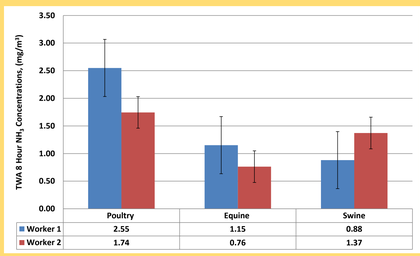


The personal monitoring badges outfitted by the workers were subjected to analytical analysis in the lab following the National Institute of Occupational Safety and Health (NIOSH) Analytical Method 6015 (Visible Absorption Spectrophotometry). Analysis required the use of TNT vials which contained indophenol blue that reacted with NH_3 when A portion of the resulting solution was added to the vial. TNT vials are an easy way to measure the concentration of a material inside them using a spectrophotometer based on transmittance and absorbance using light. High and Low rate vials were used for accuracy purposes.

Analysis and Results

Mean 8-Hour TWA personal exposure concentrations ranged from 0.04 to 6.99 mg/m^3 NH_3. Poultry workers were exposed to 127% and 91% higher concentrations than equine and swine workers, respectively. Exposure of workers within the poultry and the equine facilities varied significantly (P=0.0004 for poultry, P=0.0001 for equine), while workers at the swine facility were exposed to similar concentrations (P=0.0802). Workers' activities varied during the sampling period. On the average, about 72, 75, and 81 min/day were spent by the poultry, equine, and swine workers, respectively in the environments where ammonia was generated.

Regarding aerial measurements, NH_3 concentrations in the equine and swine facilities during the sampling days were 98% and 92% respectively lower than its concentrations in the poultry facility, while the NH_3 concentrations in the equine facility were 83% lower than the swine facility. NH_3 concentrations were not the same for each facility during the 10 sampling days (P = 0.0213), NH_3 concentrations were not the same every day in each facility (P = 0.0004), and there was an interaction between day and facility in mean NH_3 concentrations (P < 0.0066).



Differences in Average Personal Exposure Levels for Workers at the Three Facilities (N=60).

Facility	8-Hour TWA NH_3 (ppm)	8-Hour TWA mg/m^3	Standard Deviation
Poultry	38.09	32.26	21.29
Equine	0.52	0.44	1.77
Swine	2.97	2.52	0.28

8-Hour TWA NH_3 (ppm and mg/m^3) for Aerial Exposure for Each Facility over the Whole Sampling Period. (N=110).

Conclusions and Recommendations

- The highest 8-Hour TWA concentration for personal exposure was 6.99 NH_3 (mg/m^3) from the poultry facility.
- Based on the compliance testing that was done referring to NIOSH's occupational exposure sampling strategy manual, none of the workers was exposed to NH_3 concentration that exceeded the Permissible Exposure Limit (PEL=50 ppm) that is set by the Occupational Safety and Health Administration (OSHA).
- Only chicken houses recorded high concentrations of NH_3 where the 8-Hour TWA exposures exceeded 50 ppm.
- It is recommended for poultry workers to wear half mask respirators inside broilers to minimize their exposure to NH_3.
- Increased ventilation rate in chicken houses and other animal facilities during winter time is highly recommended.
- Using soybean hulls and wheat middling as feed types instead of starter feed for chickens may reduce the NH_3 concentrations by 50%.

Acknowledgments

Department of Agriculture

- Dr. Joey Bray, Assistant Professor and Director of Poultry Science
- Dr. Stacie Appleton, Assistant Professor and Director of Equine Center
- Dr. John Mehaffey, Assistant Professor and Director of Swine Center
- Mr. Justin Glasscock, Operations manager of Poultry Center
- All participating students at the animal facilities