Evaluation of methods for controlling and monitoring occupational exposure of workers in swine facilities

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SUMMARY

This study assesses the effectiveness of selected engineering and management measures, namely, oil sprinkling, low protein diet, high level of cleaning and manure pH manipulation, in reducing ammonia (NH_3) and respirable dust concentration in swine production rooms. Six grow-finish rooms at PSCI research facility were used with two as control and four as experimental rooms each employing one of the measures being investigated. Sampling equipment was installed in each room for measurement of ammonia and respirable dust concentrations within the room airspace. Worker exposure to ammonia and dust from the rooms was also assessed by equipping workers with personal monitoring gear similar to those installed in the rooms. Ammonia levels were monitored using both the standard method and using commercial gas sensors. Results from completed trials so far showed that low-protein diet, pH manipulation of manure and employing high level of cleanliness could potentially reduce ammonia concentrations in swine production rooms. Among these measures, only spraying of canola oil reduced dust levels inside the rooms. Moreover, average daily gain of pigs was relatively similar between control and experimental rooms. A benefit-cost analysis will be conducted after all trials are completed.

INTRODUCTION

Various engineering and management measures have been shown to control air contaminant levels in swine production facilities. Additionally, barn operators have come up with innovative measures to address issues with ammonia and dust levels within their facilities. However, there is a gap in translating the results observed in previous contaminant control studies to actual reduction of personal exposure of workers to these contaminants throughout their workday. Thus, there is a need for these innovative measures to be assessed under actual swine barn conditions to determine the actual reduction of exposure of workers to air contaminants. The goal of this project is to assess the effectiveness of selected engineering and management measures (i.e. oil sprinkling, low protein diet, high level of cleaning and manure pH manipulation) in reducing ammonia (NH_3) and respirable dust concentration in a swine production room. In addition, the performance of commercial gas monitoring devices was assessed using standard gas measurement method as reference.

"Providing pigs with low protein diet, manipulation of manure pH, and employing a high level of cleanliness inside barn facilities could potentially reduce ammonia concentrations"

EXPERIMENTAL PROCEDURES

Six grow-finish rooms at the PSCI barn were used for this study. The four (4) types of engineering and management measures were applied individually in 4 of the rooms (Experimental) while the other 2 rooms were managed as conventional rooms (Control). Each 16-week grow-out period was considered as one replicate trial and a total of 5 trials will be conducted to cover each climatic season (winter and summer conditions) at least twice. Every 3 weeks, the

Figure 1. Barn worker wearing the personal sampling equipment for ammonia and respirable dust while doing pig health and room checks in their assigned rooms.

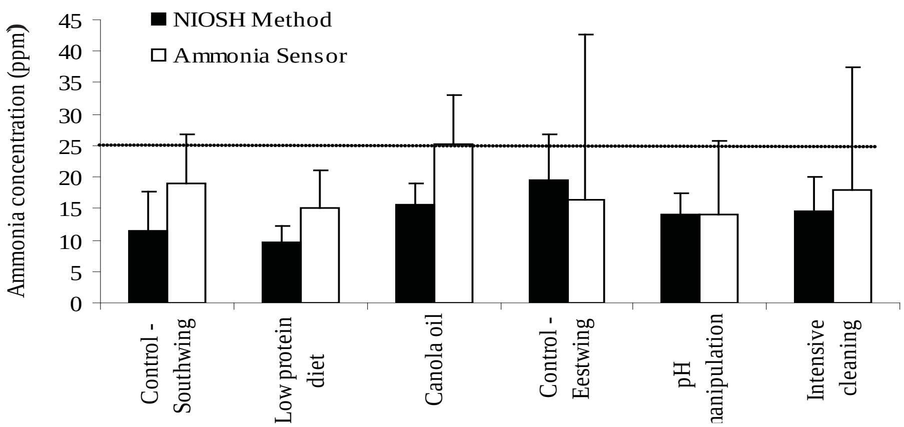

Figure 2. Ammonia concentrations measured in the control and experimental rooms using the NIOSH method and gas sensor. A line across the 25 ppm concentration indicates the ACGIH Threshold Level Value (TLV) for ammonia.

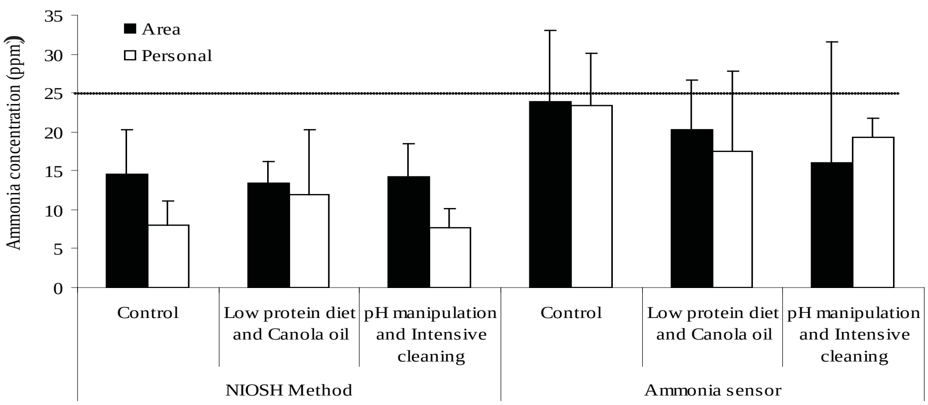

Figure 3. Ammonia concentrations measured in the control and experimental rooms by area and personal sampling using the NIOSH method and gas sensor. A line across the 25 ppm concentration indicates the ACGIH Threshold Level Value (TLV) for ammonia.

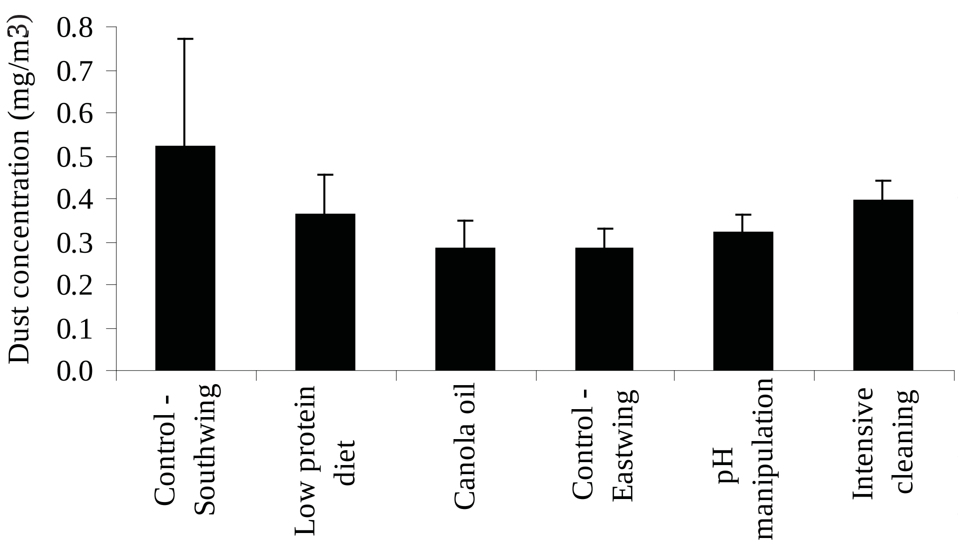

Figure 4. Respirable dust concentrations measured in the control and experimental rooms. ACGIH Threshold Level Value (TLV) for respirable nuisance dust is 3 mg/m3.

personal exposure of workers to NH_3 and dust was assessed by outfitting 3 workers with gas monitors and personal dust samplers over their work shift over a 2-day period (Figure 1). Two workers were assigned to work in the experimental rooms while the other worker was assigned in the control rooms. Each worker was assigned a logbook to document their activities during their workshift while wearing the personal monitoring gear. After each 2-day personal exposure monitoring event, area sampling within the rooms were conducted over 24 hrs to determine NH_3 levels and over 48 hrs for respirable dust concentrations.

RESULTS

The results obtained from the first two trials are summarized below. Ammonia and respirable dust levels shown are average of measurements obtained over 4 sampling events in each trial. As shown in Figure 2, ammonia concentrations in rooms with measures such as feeding low protein diet, manure pH manipulation, and high level of cleanliness were found to be substantially lower than in the control rooms. Furthermore, it was observed that the readings from the commercial gas monitoring devices were considerably higher than the concentrations determined from the standard NIOSH method (Figure 3). However, the measured values from all rooms were below the threshold limit value of 25 ppm NH_3.

For the dust levels, only spraying of canola oil showed the potential to reduce dust concentration as shown in Figure 4; this was expected since the canola oil spray helped keep dust on the surfaces from being entrained into the air. Nevertheless, it should be noted that the dust levels in all the rooms were below the threshold limit value of 3 mg/m^3. Comparison of area and personal sampling methods for monitoring dust levels showed that the concentration values obtained from personal sampling were significantly higher than the values obtained from area sampling (Figure 5).

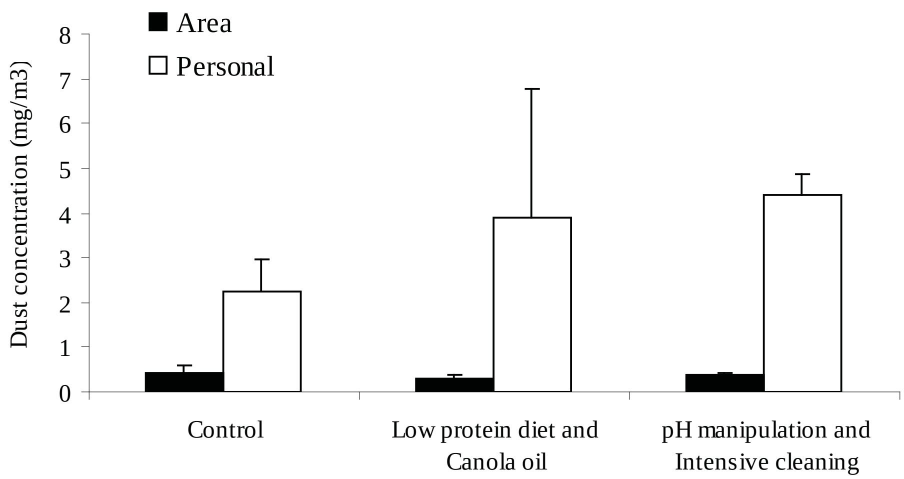

Figure 5. Respirable dust concentrations obtained in the control and experimental rooms by area and personal sampling measurements. ACGIH Threshold Level Value (TLV) for respirable nuisance dust is 3 mg/m^3.

Table 1. Average daily gain (ADG) and mortality rate of pigs in the control and experimental rooms.

	ADG (kg/day-pig)		Mortality (%)	
	Average	SD	Average	SD
Control (n=440)	0.96	0.09	3.89	5.95
Low crude protein diet (n=240)	1.03	0.23	0.42	1.31
Canola oil (n=240)	1.00	0.09	0.80	2.76
pH manipulation (n=200)	1.04	0.08	0.00	0.00
High level cleaning (n=200)	1.02	0.13	2.00	4.10

n = number of pigs specified to each treatment

This could be due to the different sampling durations; area sampling was conducted over the 48 hours while personal sampling was done in a much shorter period. Sampling duration is a significant factor in the calculation of dust concentration. Longer sampling durations would lead to larger sample volumes; since dust generation is not uniform over the sampling period this leads to lower calculated dust concentrations.

Pig performance

The average daily gain and mortality rate of pigs in the control and experimental rooms are shown in Table 3. Average daily gain of pigs in all rooms was relatively similar ranging from 0.95-1.03 kg/day-pig. However, mortality rate was higher in the control rooms with 6.94% compared to the experimental rooms (0-4.0 %). From data collected so far, the difference in pig mortalities between the treatment and control rooms could not be attributed to the levels of ammonia measured in the rooms.

IMPLICATIONS

The results from the completed trials of this study showed that providing pigs with low protein diet, manipulation of manure pH, and employing high level of cleanliness inside barn facilities could potentially reduce ammonia concentrations.

On the other hand, only the spraying of canola oil showed the potential to reduce respirable dust concentration. The different engineering measures employed in this study showed no significant impact on the animal performance. Three more trials will be implemented and a benefit-cost analysis of the various engineering measure employed in this study will be conducted.

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