Evaluation of Methods for Controlling and Monitoring Occupational Exposure of Workers in Swine Facilities

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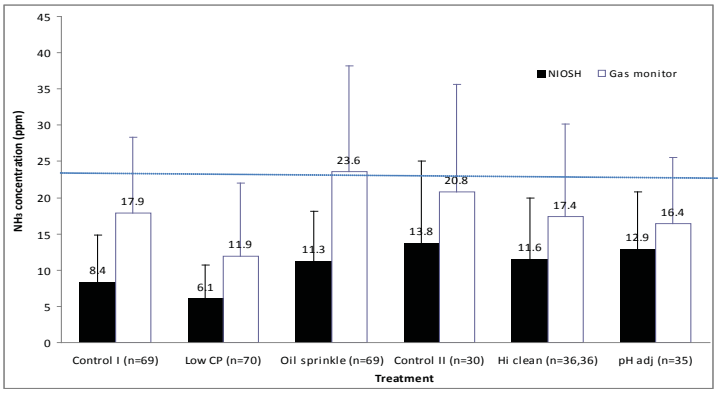
SUMMARY

This study was aimed to assess the effectiveness of canola oil sprinkling, low crude protein diet, high level of cleaning and manure pH manipulation, in reducing ammonia and respirable dust concentrations in swine production rooms. Among the control measures tested, low protein diet reduced ammonia concentrations while canola oil sprinkling tended to result in lower respirable dust levels. Personal monitoring showed higher level of worker exposure compared to area sampling. Ammonia gas monitors yielded higher readings than the standard (NIOSH) method.

"When compared to the standardized scientific method for measuring gases, portable commercial monitors yielded higher readings"

Figure 1. NH_3 (A) and respirable dust (B) concentrations measured in the control and treatment rooms by area sampling. Ammonia levels were determined using gas monitors and NIOSH method.



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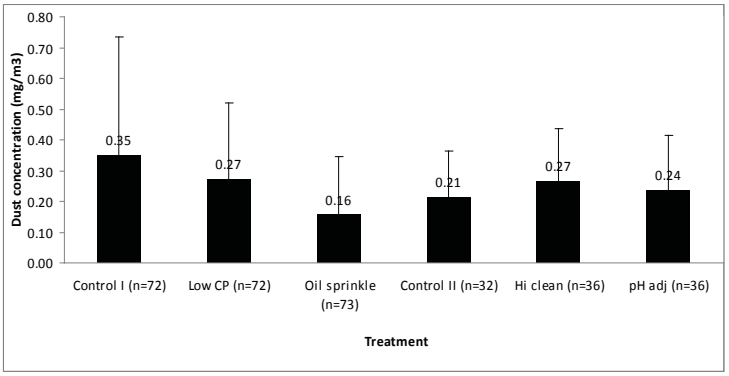

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INTRODUCTION

Various engineering and management measures have been shown to control the levels of air contaminants such as ammonia and dust in swine production facilities. In this study, the effectiveness of selected control measures was assessed under swine production conditions to document their impact on ammonia (NH_3) and respirable dust levels, and to determine the actual reduction of personal exposure of workers to these contaminants throughout their workday.

EXPERIMENTAL PROCEDURES

Six grow-finish rooms at PSCI barn facility were used in this study. Four (4) types of engineering and management measures (treatment) were applied separately in four of the rooms. These measures include the use of low crude protein diet, canola oil sprinkling, high level of cleaning, and pH manipulation of manure. Two other rooms were managed as conventional (control) rooms with no measures applied. Each trial was run for 16 weeks. Every 3 weeks, the 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 for 2 days. Two workers were assigned to work in the treatment rooms while the other worker was assigned in the control rooms. Each worker had a logbook to document their activities during their work shift while wearing the personal monitoring gear. After each 2-day personal exposure monitoring event, area sampling was conducted in each test room over 24 and 48 hours to determine NH_3 and respirable dust concentrations, respectively.

RESULTS

NH_3 and respirable dust concentrations in the room airspace

Figure 1-A shows the mean NH_3 concentrations in treatment and

control rooms measured by area sampling. The results showed that the commercial gas monitor readings were higher than the values obtained from the NIOSH method (sorbent tubes) in both control and treatment rooms. This may be attributed to the fundamental differences in the principles employed by the two methods in generating the target gas concentration values. Nevertheless, both the gas monitor and the NIOSH method showed that the treatments with low crude protein diet had significant effect on NH_3 concentration ($P<0.05$), while the other treatments did not show statistically significant effect compared to the control rooms.

As shown in Figure 1-B, average respirable dust concentration in the rooms applied with canola oil and low crude protein diet was lower than in the corresponding control room, while those in rooms with pH manipulation of manure and high level of cleaning treatments have slightly higher dust concentration than the corresponding control room. However, statistical analysis indicated that the observed differences were not significant ($P>0.05$).

Worker exposure to ammonia and respirable dust

For NH_3 concentration, the gas monitor values were generally higher than the NIOSH method values as previously observed. However, NH_3 readings from both analytical methods showed that personal monitoring yielded values comparable to area sampling as shown in Figure 2. Regardless of which sampling method was used, most of the personal exposure values were below the 25 ppm NH_3 threshold limit value set by ACGIH.

All personal sampling results showed much higher respirable dust concentrations than area sampling (3.0 to 6.0 mg/m3 vs. 0.16 to 0.35 g/m^3, respectively) as shown in Figure 3. This was expected since with personal sampling, the sampler was worn by the worker while performing specific tasks (i.e., feeding), thus the samplers could capture more contaminants closer to the source; whereas with area sampling, the sampler was at a fixed location and would be able to capture only the airborne contaminants dispersed by the ventilation system towards the location of the sampler. In addition, personal sampling was usually conducted at daytime when all pigs were active and dust generation was higher, whereas area sampling duration covered both daytime and night time hours when pigs were asleep and dust generation was low. Most of the personal sampling results were over the 3 mg/m3 threshold limit value established by ACGIH for airborne respirable particulates in the workplace.

Research Associate Yaomin Jin taking an air sample

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

Treatment	ADG (kg/day-pig)	Mortality (%)
Control	1.00 ± 0.06	2.75 ± 2.68
Low crude protein diet	1.07 ± 0.15	1.28 ± 1.72
Oil sprinkling	0.98 ± 0.04	1.07 ± 0.82
pH manipulation	0.99 ± 0.07	0.37 ± 0.50
High level cleaning	1.02 ± 0.06	1.33 ± 1.88

Pig performance

From the pig weight data taken on Week 0, 6, and 12 of each trial, the observed average daily gain (ADG) of pigs were relatively similar in both control and treatment rooms (Table 1), ranging from 0.98 to 1.07 kg/day-pig. Similarly, the mortality rate in the treatment rooms was not significantly different from that in the control rooms ($P>0.05$).

CONCLUSIONS

From the completed trials, results showed that ammonia and respirable dust levels in treatment and control rooms were generally below the threshold limit values (25 ppm for NH_3 and 3 mg/m^3 for respirable dust) set by ACGIH. Personal monitoring, however, indicated that worker exposure to dust exceeded the 3 mg/m^3 threshold limit value. Supplemental trials are needed to arrive at definitive conclusion on the effect of the different measures on respirable dust and ammonia. Ammonia gas monitors yielded generally higher readings compared to the standard analytical method; this trend does not compromise worker safety as this would mean that the use of gas monitors would provide early indication of potentially hazardous levels of ammonia.

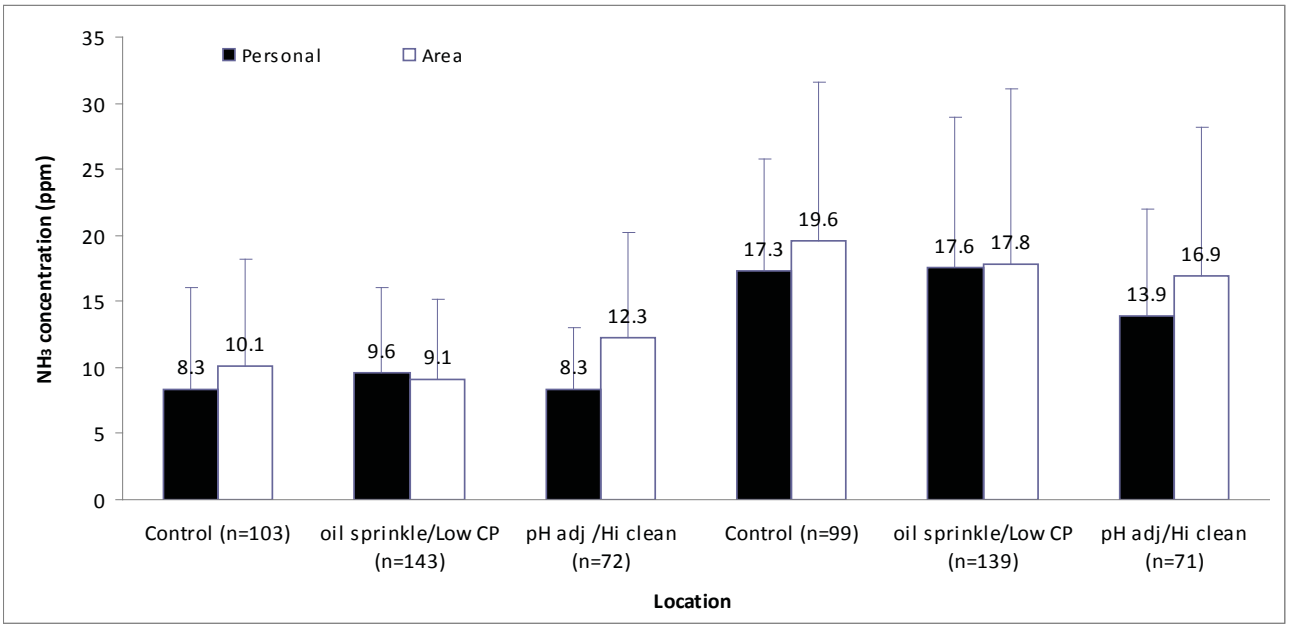

Figure 2. Comparison of NH_3 concentrations obtained by personal and area sampling using gas monitors and NIOSH method

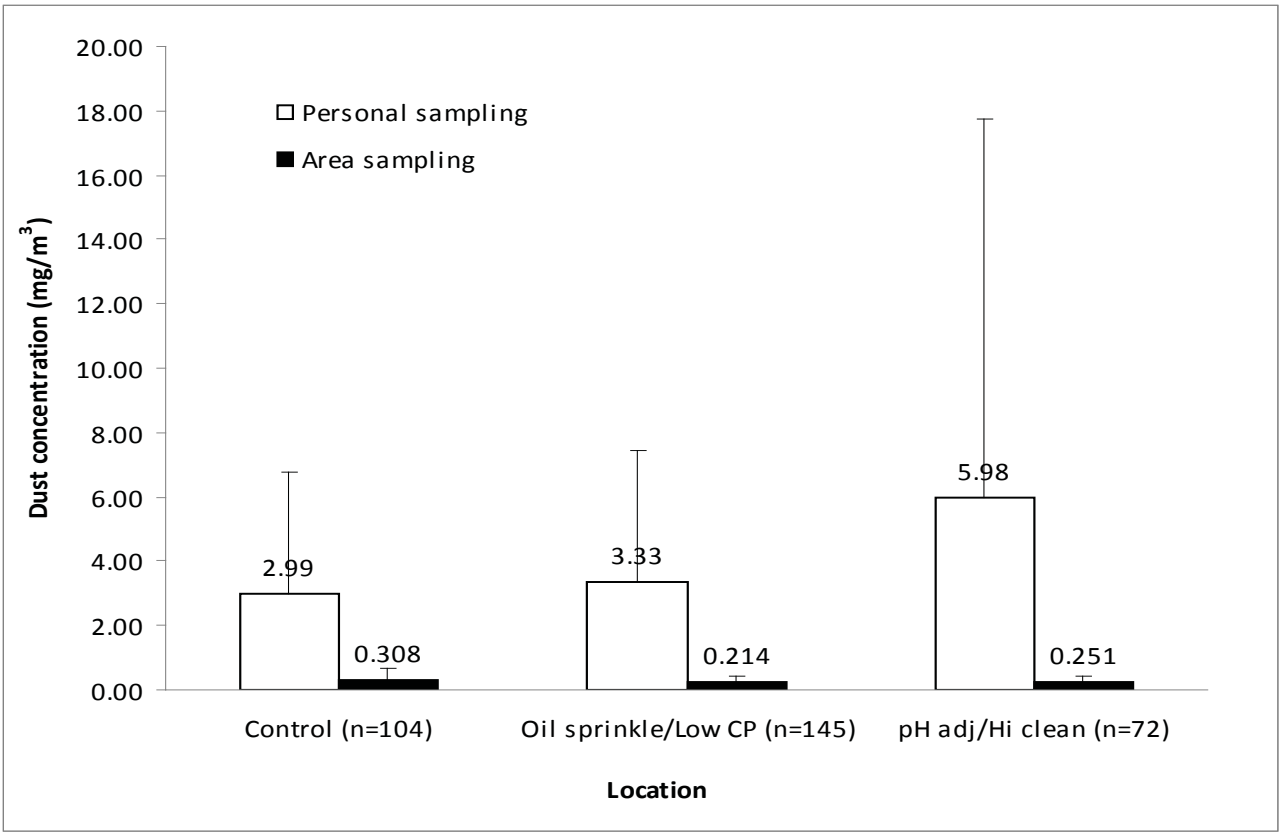

Figure 3. Respirable dust concentrations obtained in the control and experimental rooms by personal and area sampling.

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