

What Airborne Contaminants are Pig Barn Workers Exposed to - Really?

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■ Introduction

Pig barn workers are exposed to dust, gases, and endotoxins (Wenger, 1999). Pig barn dust originates from many sources including pig dandruff, dried fecal material and from feed. The gases workers are exposed to include NH₃ (from drying manure and urine on solid floor surfaces), H₂S (a by-product of anaerobic breakdown of manure) and CO₂ gas (a by-product of pig and worker respiration). Endotoxins are constituents of the cell walls of gram negative bacteria.

To date, there has been no published research on the concurrent, simultaneous personal exposures of specialty pig barn workers to important contaminants in pig barn environments. This manuscript will describe a research study that was recently conducted by the University of Alberta.

■ Purpose of the Study

The purpose of the research study was to identify and quantify the exposures to airborne contaminants of specialized career pig barn workers during low ventilation rates in winter and high ventilation rates in summer. Only preliminary results from the summer exposures will be presented in this manuscript.

■ Study Methodology

Workers in each of 10 barns in Alberta, wore Personal Environmental Sampling Backpacks (PESBIs) (Ouellette, et.al., 1999) throughout their entire work-

shifts, over 3 consecutive days in one week (Tuesday through Thursday), one barn per week, in the winter and summer of 2000. The work-shift exposures of three specialties of pig barn workers were monitored: Dry Sow/Breeding (DS/B), Farrowing (Farr), and Nursery/Grower/Finisher (N/G/F).

The PESBIs stored data at 10 second intervals throughout the entire work day. The contaminants that were monitored included: respirable dust counts in 4 size fractions (>0.3 microns, >0.5 microns, >1.0 microns, and >5.0 microns); gases (CO₂, NH₃, and H₂S), relative humidity and indoor temperature. Due to the limitations in data storage capacity, the data for NH₃ and H₂S were stored every 20 seconds. Dust was also collected on glass fiber filters using a cyclone to select only the respirable dust, and this dust was used to quantify airborne concentration of endotoxins.

■ Descriptive Results

The average number of sows per study barn was 1345, ranging from 350 to 2400 sows. Of the ten barns visited, 8 were farrow to finish, while two were farrow to early wean facilities (one had an on-site, detached nursery facility). The average number of employees per barn was 7.5, ranging from 3 to 18 workers.

Table 1. Demographics of workers whose exposures were monitored.

	Pig Barn Worker Specialty			
	All	Dry Sow, Breeding	Farrowing	Nursery, Grow- Finish
Number	38	13	11	14
Age (mean ± SD)	33.9 (9.5)	36.9 (10.5)	31.9 (8.0)	32.8 (9.5)
Gender, #				
Males	26	10	5	11
Females	12	3	6	3
Years in present barn (mean ± SD)	1.5 (2.1)	1.8 (2.2)	1.5 (1.8)	1.3 (2.4)
Work-shift, hrs (mean ± SD)	9.2 (0.8)	9.0 (0.8)	9.2 (0.8)	9.3 (0.7)

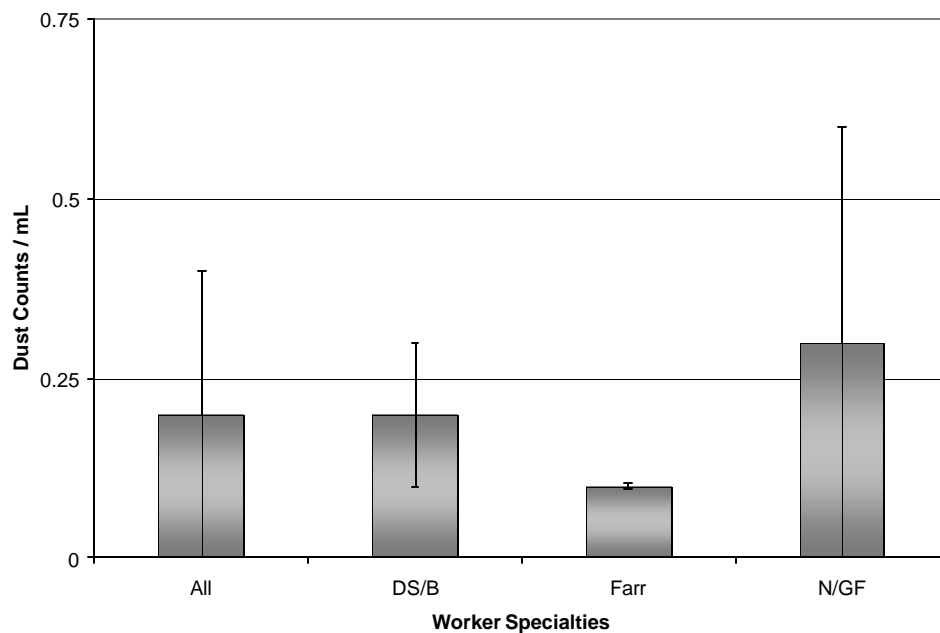
As can be seen in Table 1, there were slightly more dry sow, breeding and nursery, grow-finish workers than farrowing workers monitored because of the method employed in assigning the fourth PESBII. The average age of the workers was 33.9 years, with 68.4 % of the workers being male. Worker turnover in pig barns is often high; workers in this study were employed in the study barns for an average of 1.5 years. Workers' exposures were monitored for 9.2 ± 0.8 hours in this study, which is considerably longer than comparable studies, because of the larger sizes of barns visited in this study.

Given the space limitations, only selected contaminants will be highlighted in this manuscript.

Respirable Dust

Preliminary study results show no differences between worker specialty and dust exposure for dust particles <5.0 microns in size. However, for dust particles >5.0 microns, the data showed a significant difference between farrowing workers (Farr) and nursery, grow-finish (N/GF) workers ($p < 0.001$) (Figure 1). There also appears to be a difference between dry sow, breeding (DS/B) workers and nursery, grow-finish workers, but this difference was not found to be significant ($p = 0.06$).

Figure 1. >5.0 microns dust counts/mL for different specialty workers.



Pig Barn Gases

Ammonia (NH₃) gas

No NH₃ results are presently available. A cross-sensitivity reaction was found between the background levels of H₂S gas present in the pig barn environment and the NH₃ sensors that were used for NH₃ quantification. This cross-sensitivity resulted in erroneous NH₃ readings. Laboratory analyses are on going to establish a correction factor for the NH₃ data.

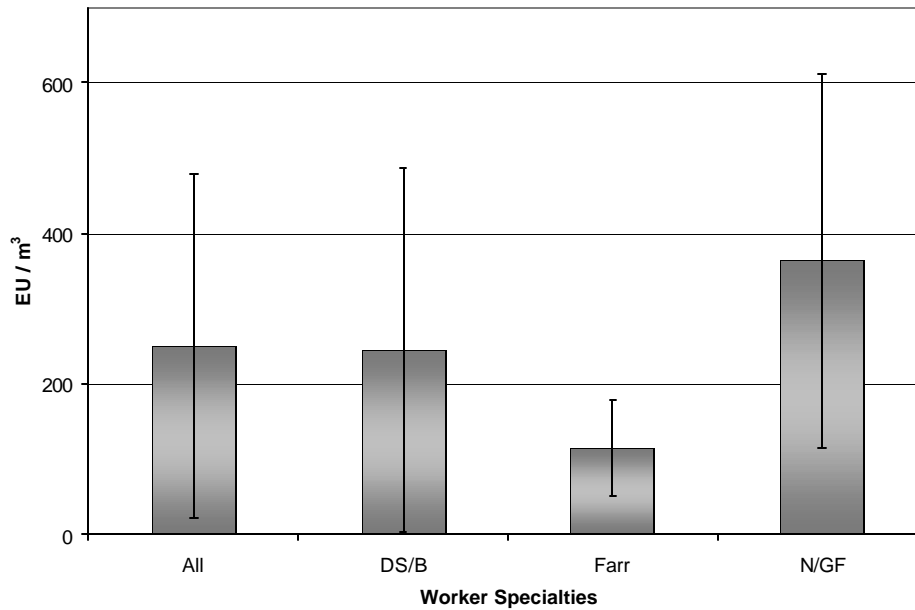
Hydrogen Sulfide (H₂S) gas

Overall, the average work-shift H₂S exposures among the pig barn workers enrolled in this study were low (<1.0 ppm), and no significant differences were found among the three worker specialties (p=0.43). However, the data showed that the present H₂S ceiling occupational exposure limit of 20 ppm (http://www.gov.ab.ca/hre/whs/law/rpc_chemhaz.htm) was exceeded at least one time by 10% of the workers. A ceiling exposure limit for H₂S means that, according to the Chemical Hazards Regulations, a worker cannot be exposed to a level of H₂S gas higher than 20 ppm at any time during the work-shift. There is a proposal to have this ceiling limit lowered from 20 ppm to 15 ppm (V. Goodwin, personal communication). According to the study data, if this lower ceiling were in place today, 17% of the workers would exceed the new regulations. Work activities that cause these unacceptably high H₂S exposures need to be identified, and steps need to be taken to remediate these exposures. Activity data collected throughout the study will provide the tools necessary for making this determination.

Endotoxins

Preliminary study results show a significant difference between farrowing and nursery, grow-finish workers in Endotoxin Units per m³ (EU/m³) (p<0.01) (Figure 2).

It is not clear at present why the nursery, grow-finish workers had such a high exposure to endotoxins.

Figure 2. Endotoxin units / m³ exposures for specialty pig barn workers.

Relative Humidity (RH)

The study data showed a trend towards a higher RH% in the nursery, grow-finish areas when compared to the dry sow, breeding area ($p=0.07$). Perhaps this is due to a higher stocking density in the nursery, grow-finish area and thus more moisture in the air due to higher pig respiration volumes, or insufficient barn ventilation rates.

■ Study Implications

Preliminary study results suggest that all career pig barn workers are not equally exposed to individual contaminants present in the pig barn environment. Farrowing barn workers appear to be the least exposed to both >5.0 micron dust and to endotoxins, while workers from the nursery, grow-finish specialty were most exposed to these two contaminants.

Data analysis is continuing on the summer and winter exposure data sets, as well as the worker activity and respiratory health questionnaire data sets. Barn management variables including animal density and barn cleanliness will also be evaluated as possible predictors of the contaminant exposures observed.

■ Acknowledgements

The author would like to gratefully acknowledge the funding sources for this study: the Canada-Alberta Hog Industry Development Fund, Alberta Agriculture, Food and Rural Development, and NSERC. The author would also like to thank the pig barn owners and managers who allowed us access to their barns and the barn workers who allowed us to follow them and to collect information from them.

■ References

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