FACTORS AFFECTING THE CONCENTRATIONS OF AIRBORNE PARTICLES IN AUSTRALIAN PIGGERY BUILDINGS

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Introduction

Airborne particles in piggery buildings consist of animal skin, hair, dried urine, faeces, bedding material, microorganisms, grain and other particles (Wathes 1994). High airborne particle concentrations could potentially effect production efficiency, human and/or animal health and the environment (Takai *et al.* 1998). A number of previous studies have demonstrated that different management, environmental and housing factors influence the concentrations of airborne particles within piggery buildings (Gustafsson 1999). However, these factors have not been evaluated simultaneously using a statistical modelling approach. Therefore, a comprehensive study of air quality in piggery buildings was designed and used to determine the key piggery design and management factors that affect the internal concentrations of airborne particles in piggery buildings.

Material and Methods

The detailed methodology of the study was described by another paper in this series, so only a brief outline is given here (Banhazi *et al.* 2004). The concentration of respirable and inhalable particles was determined gravimetrically using standard cyclone dust sampler and “seven-hole” sampler (SKC Inc., Pennsylvania), respectively. The dependent variables of interest were inhalable and respirable particle concentrations and the log-transformed data was analysed using a general linear model procedure (SAS 1989). The results from this analysis presented are based on Least Squares Means of fixed effects and best-fit slopes of covariates, where relevant.

Results

The main factors identified to affect the concentrations of inhalable and respirable particles are summarised in Table 1. Selected results from the GLM analysis are shown in Figure 1-2. Generally temperature and sow numbers (indication of farm size) displayed a positive, while increased airflow a negative relationship with airborne particles (Figure 2.). The effect of humidity varied in different buildings and the effects of temperature and airflow interacted with management (Figure 1 and 2.).

Table 1. Significant effects associated with inhalable and respirable particles (P<0.01).*

Inhalable particles (R^2 = 0.726)	**Respirable particles (R^2 = 0.689)**
Seasons	Building type x hygiene
Number of sows	Number of sows x seasons
Building type x temperature	Humidity x building type
Airflow^2 x management	Air flow x management
Building size x management	Temperature x management
	Humidity x management

*(*Effects involved in interactions were retained as main effects.)*

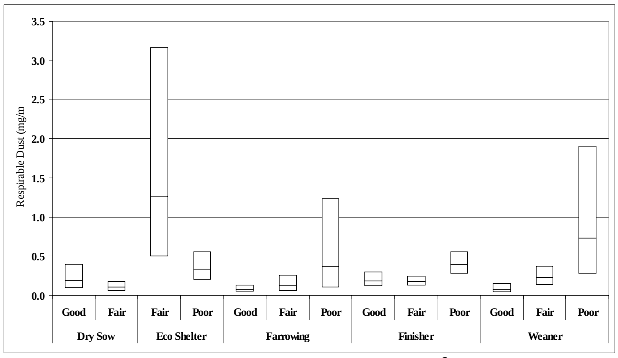

Figure 1: Effects of floor hygiene/building type interactions on respirable particle concentrations (mg/m^3) in Australian piggery buildings (LS means with 95% confidence intervals).

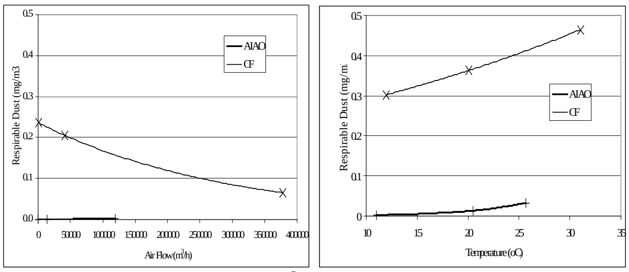

Figure 2: Effects of temperature and airflow on respirable particle concentrations (mg/m^3) in Australian piggery buildings (estimated slopes).

Higher inhalable particle concentrations were measured in winter (2.95 mg/m^3) in piggery buildings compared to summer (1.68 mg/m^3) and the effect of sub-optimal floor hygiene was significant and varied in different buildings (Figure 1-2.). The models developed explained approximately 70% of variation in both traits.

Discussion

A number of important factors affecting both the respirable and inhalable particle concentrations inside pig buildings were identified in this study (Table 1.). The increased humidity in the air had a reduction effect on respirable particle concentrations in deep-bedded shelters (DBS). Increased humidity would increase coagulation of particles generated from the bedding and their weight would also increase as they absorb water resulting in increased settling rate (Ellen 1999). Building type and cleanliness interacted (Figure 1) and interestingly in DBS the effect of pen soiling appeared to be beneficial. It was hypothesized, that soiling would increase the “adhesiveness” of bedding material, creating a reduction effect by trapping smaller particles and might also increase humidity inside the buildings. In farrowing, weaner and grower/finisher buildings pen soiling had a negative affect on respirable particle concentrations. It is also interesting to note that pen hygiene was not identified as a significant effect for inhalable particles. It is widely accepted that larger (inhalable) particles are mainly generated from the feed, therefore their concentrations would not be affected greatly by the hygienic condition of pens (Cargill *et al.* 2002).

In general, winter ventilation rates of piggery buildings are lower than summer rates to maintain shed temperature. Therefore, for inhalable particles, an increase has been demonstrated in winter compared to summer (Table 1). The effect of season on respirable particles was more complex as it interacted with sow numbers (farm size) (Table 1).

The size of farm (as described by the number of all sows on the farms) had a significant effect on both inhalable and respirable particle concentrations (Table 1). Inhalable particle concentrations were strongly and positively associated with sow numbers. However, the effect of sow number on respirable dust was more complex. It has been hypothesised that on larger farms, due to work pressures, less time is available for cleaning and general maintenance of the environment of the pigs. The reduced hygiene and/or increased intervals between cleaning episodes creates an ideal environment for higher dust concentrations in buildings on larger farms (Cargill and Banhazi 1998).

Generally, temperature had a positive correlation with both inhalable and respirable particles (Figure 2). As temperature increases, piggery buildings tend to become a drier environment, creating greater opportunities for particle generation (Takai *et al.* 1998). Because of increased temperature, respirable particle concentrations increased dramatically in CF buildings, but also slightly in AIAO buildings. Inhalable particle concentrations were also significantly effected by temperatures, but the relationship was more complex due to interaction with buildings type (Table 1).

Based on the results of the study, improving pen hygiene, reducing excess temperature and improving ventilation should be considered as the main recommendations for Australian piggery buildings. Treatment of bedding materials in deep-bedded shelters is also advisable to reduce the opportunities for particle generation (Banhazi *et al.* 2002). Larger farms might also need to pay extra attention to air quality issues.

Conclusion

1. Deep-bedded shelters showed high inhalable and respirable particle concentrations.
2. Respirable particle concentrations were higher in pig buildings with poor pen hygiene.
3. Inhalable and respirable particle concentrations increased with increasing temperatures.
4. Particle concentrations decreased with increasing ventilation rates and in summer, increased as the size of the farms increased.

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