IMPROVING AIR QUALITY IN PIGGERY BUILDINGS

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SUMMARY

The negative effects of high concentration of bioaerosol on animal health, welfare and productivity are well documented. Reducing the concentration of airborne particles in piggery buildings is therefore an important task and could also help to reduce the occupational health and safety risk associated with farm workers. The objective of this research was to evaluate the effects of spraying a mixture of oil and water directly onto pen floors on the concentration of airborne particles inside piggery buildings. Air quality parameters were recorded in a number of partially slatted, mechanically or naturally ventilated pig facilities. The floor of one of the experimental rooms was sprayed daily with a mixture of canola oil and water (50:50) at the rate of 3 g/pig, using an automatic spraying system, while the other room was not treated (control facility). Airborne pollutant concentrations were measured and compared between the two treatments. The concentration of both inhalable and respirable airborne particles was significantly reduced in the experiment facilities.

Key words: pigs, air quality, spraying, reduction, emission, dust, airborne particles

INTRODUCTION

Dust is one of the major airborne pollutants associated with intensive livestock production and determines the quality of the environment within livestock buildings (Wathes 1994). The negative effects of high concentration of bioaerosol on human and animal health, as well as on animal welfare and productivity are well documented (Donham 1991; Donham & Leininger 1984; Donham *et al.* 1984). Suspended airborne particles can also absorb toxic and noxious gases as well as bacteria components and act as vectors for these pollutants (Donaldson 1977). High concentrations of airborne particles may contain bacterial toxins and appears to enhance both the prevalence and severity of respiratory diseases in pigs (Cargill *et al.* 1998). Reducing the concentration of airborne particles in piggery buildings is therefore an important component of good management and can improve production efficiency and reduce the potentially harmful effects of long term exposure to humans (Donham *et al.* 1989).

In addition, Australian data suggests that an average enterprise of 200–400 sows on a single site would release significant amounts of dust, bacteria, ammonia and endotoxins into the surrounding environment via emissions from buildings (Banhazi *et al.* 2006). Emissions, especially ammonia emissions from pig farms are now very closely regulated in the EU and excessive emissions could result in reduced market access of individual piggery operators (Arogo *et al.* 2001; Phillips *et al.* 2001; Wathes *et al.* 1998). Therefore, simple, low-cost and practical techniques, which will have the potential to deliver a significant reduction of odour, ammonia and other pollutant emissions cost effectively, need to be investigated, developed and evaluated

(Aarnink *et al.* 1997). Spraying the floor of pig sheds with a mixture of oil and water (Takai *et al.* 1995) is a potentially beneficial technique. Furthermore, publications from the USA also indicate that odour and possibly ammonia emissions can be reduced by oil spraying (Jacobson *et al.* 1998).

Therefore, the objective of this project was to evaluate the effects of oil spraying and other airborne pollution reduction techniques, primarily on the concentration of airborne particles inside piggery facilities, but the effects of applications on the concentration of other airborne pollutants were also investigated. As a result of reduced internal concentration levels, marked reduction can also be achieved in pollutant emission, assuming the same level of ventilation.

MATERIAL AND METHODS

An automated oil spraying system was installed in a number of piggery buildings. Information on the general design concept of oil spraying systems have been published previously (Banhazi 2005; Lemay *et al.* 1999; Takai & Pedersen 1999). Air quality parameters were recorded for 32 days in two partially-slatted, mechanically ventilated weaner rooms housing 89 pigs (approximate mean live weight 18 kg) and for 16 days in two partially-slatted, naturally ventilated grower rooms housing 91 pigs (approximate mean live weight 42 kg). The floor of one of the rooms (experimental facility) was sprayed daily with a canola oil, water and surfactant mixture at a 4:5:1 ratio and at the rate of 3 g/pig (6.3g/m^2), using an automatic spraying system. The other room was not treated and served as a control facility. Air quality parameters (as described below) as well as the growth rate of animals were also measured throughout the trials.

Temperature and humidity data were recorded in all sheds monitored using Tinytalk temperature and humidity loggers (Hasting Dataloggers, Tinytalk-2). The sensors were placed as close to pig level as practically possible, without allowing the pigs to interfere with the instruments. Most loggers were attached to the ceiling or a beam, using wire cable and were lowered to pig level above a selected pen, representing the average condition of the shed. Total inhalable and respirable particle concentrations were measured using air pumps connected to cyclone filter heads (for respirable particles) and Seven Hole Sampler (SHS) filter heads (for inhalable dust) and operated at 1.9 and 2.0 l/min flow rate, respectively. The pumps were operated over a 6 or 8-hour period. The selection of the monitoring period was based on previous studies (Pedersen 1993). After sampling, the filter heads were taken back to the laboratory and weighed to the nearest 0.001 milligram using certified microbalances and then the inhalable and respirable dust levels were calculated.

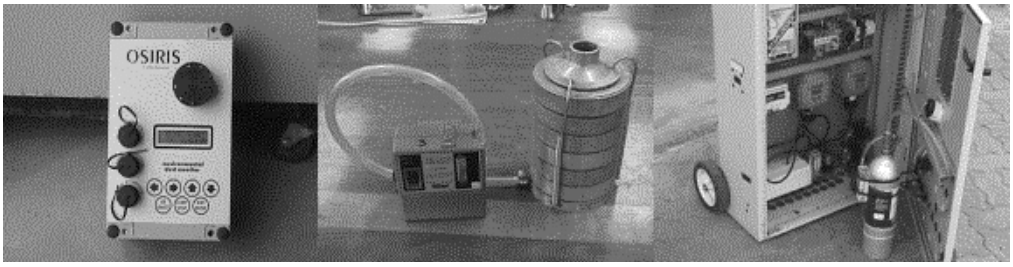

Figure 1. Measurement equipment used during the study included the (1) OSIRIS particle monitoring equipment, (2) Anderson bacteria sampler and the (3) Multi Gas Monitoring Machine, developed in-house.

Continuous dust (OSIRIS-2014, Turnkey Ltd.) monitoring equipment was used in some sheds to collect dust distribution information (Figure 1). Ammonia and carbon dioxide were monitored continuously using a gas monitoring machine (Banhazi *et al.* 2005). The equipment was calibrated (using standard 50 ppm ammonia and 2,500 ppm carbon dioxide calibration gases) as required (Figure 1). Total viable airborne bacteria were measured using an Anderson viable six-stage bacterial impactor (Clarke & Madelin 1987) filled with horse blood agar plates (HBA). The airspace was sampled for five minutes at a flow rate of 1.9 litre/minute (Figure 1). The bacteria plates were incubated for 48 hours at 37 ^{o}C and the number of colony forming units was counted manually. The figures were entered in a database and the concentration of airborne microorganisms was calculated and expressed as Colony forming Units (CFUs)/m^3. The data were analysed using ANOVA procedures (Statistica 6.1).

RESULTS AND DISCUSSION

The concentration of both inhalable and respirable airborne particles as well as airborne bacteria was significantly reduced in the experiment facilities (Table 1 and 2).

Table 1. Concentrations of respirable and inhalable airborne particles, viable bacteria and ammonia for the control and treatment rooms.

Treatment	Respirable particles (mg/m^3)	Inhalable particles (mg/m^3)	Total Bacteria (X 1000 CFUs/m^3)	Ammonia (ppm)
Weaner (Control)	0.208^a	4.023^a	67^a	11.2^a
Weaner (Treatment)	0.150^b	2.278^b	39^b	10.0^a
Grower (Control)	0.128^a	1.463^a	66^a	8.7^a
Grower (Treatment)	0.106^a	0.790^b	112^b	9.0^a

^{ab} Values in the same column with different superscripts differ significantly ($P<0.05$).

Measurement conducted using the OSIRIS optical particle counter demonstrated the visible dust reduction achieved in the experimental facilities. Although the results provided by the OSIRIS equipment were not always reliable in terms of absolute concentrations; these readings demonstrated the relative dust reduction achieved when dust concentrations in the control and experimental facilities were compared in real time.

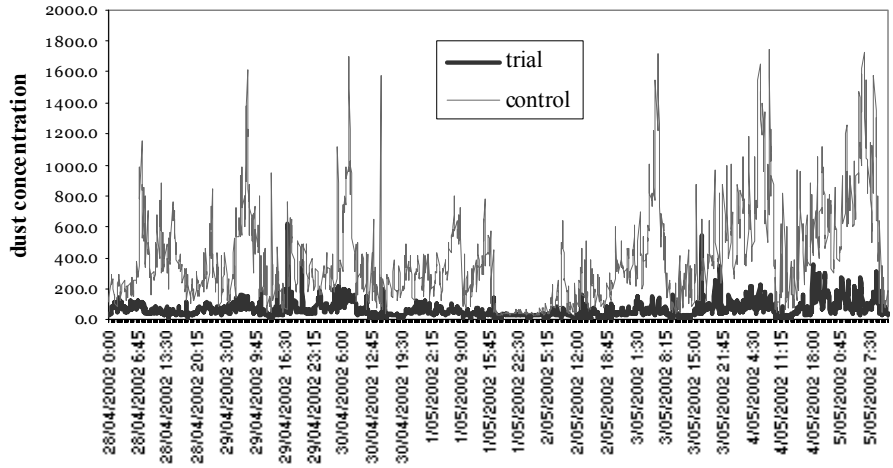

Figure 2. Airborne particle reduction achieved (Osiris measurements) at a piggery during the commercial trials (Sample data shown).

Despite the significant environmental improvement achieved, no significant difference was detected between the growth rate of the treatment and experimental groups. This is in agreement with previously published data (Takai *et al.* 1995).

The experiment achieved its aim of demonstrating a reduction in the concentrations of both inhalable and respirable airborne particles in the airspace following the direct spraying of an oil and water mixture onto the floor. This study confirmed previously published data (Takai *et al.* 1995) and the technique used in the experiment could be used by producers to effectively reduce dust levels in piggery building. However, further studies are needed to determine the long-term effects of frequent oil spraying on subsequent surface hygiene of pen floors. Overall, the technique is a safe and efficient dust reduction method and should be promoted to producers experiencing dust problems in their facilities.

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