

Exposure to particles in Portuguese swine production

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1. INTRODUCTION

Several studies have shown that human exposures to airborne dust and microorganisms, such as bacteria and fungi, can cause respiratory diseases. Agricultural workers have been found to be at high risk of exposures to airborne particles (Radon et al., 2003; Predicala and Maghirang, 2003; Baur et al., 2003; Rautiala et al., 2003; Dosman et al., 2005).

From a human health perspective dust exposure in pig farming is the most important risk because of the large number of workers needed in pig production and the increasing number of working hours inside enclosed buildings (Iversen et al., 2000).

In the pig buildings, particulate matters like dust play a role in not only deteriorating indoor air quality but also can cause an adverse health effect on workers (Donham et al., 1990; Pearson and Sharples, 1995; Mackiewicz, 1998; Kim et al., 2008).

Generally, dust is recognized to adsorb and transport odorous compounds (Carpenter, 1986) and biological agents (Robertson et al., 1984; Kim et al., 2005).

The aim of this study was to determine particles contamination in 7 swine farms located in Lisbon district, Portugal.

2. MATERIALS AND METHODS

Environment evaluations were performed during the winter season of 2010 with a portable direct-reading equipment (Lighthouse, model 3016 IAQ) and was possible obtained data concerning contamination by particles in 5 different sizes (PM0.5; PM1; PM2.5; PM5; PM10). This differentiation between particle size fractions is important because permit to estimate the penetration and deposition of dust within the respiratory system. Vincent and Mark (1981) demonstrated that respirable dust is the fraction of airborne dust that reaches the gas exchange regions of the lung and is less than 7 μm aerodynamic diameter (size from PM0.5 to PM5).

The measurements were conducted in the vicinity of nasal area of the workers and during performance of different tasks. In the swine farms, 3 to 11 measurements were undertaken and the mean value obtained for each particle size considered. All measurements were done continuously and with 5 min duration. In all swine farms studied, workers did not use respiratory protection devices.

3. RESULTS AND DISCUSSION

Particles contamination results showed that higher values were connected with PM5 and PM10 sizes. The distribution of particles size showed the same tendency in all swine farms; however, farms B and D presented higher levels of contamination, particularly in PM5 and PM10 (Table 1). These two farms were the only that just have natural ventilation as ventilation resource. The other ones have a combination between natural and mechanical (exhaust) ventilation.

Table 1. Results obtained in each swine farm (mean value/mg.m⁻³)

Swine farms	N° of measurements	PM0.5	PM1.0	PM2.5	PM5.0	PM10.0
A	11	9.1×10^{-4}	1.4×10^{-3}	5.1×10^{-3}	4.9×10^{-2}	2.4
B	7	1.9×10^{-3}	5.4×10^{-3}	1.6×10^{-2}	1.1	4.9
C	6	2.5×10^{-4}	7.4×10^{-4}	4.6×10^{-3}	4.5×10^{-2}	2.0
D	5	2.8×10^{-4}	9.3×10^{-4}	8.8×10^{-3}	1.1	5.8
E	3	2.3×10^{-3}	4.3×10^{-3}	1.2×10^{-2}	6.0×10^{-2}	1.9
F	7	1.4×10^{-4}	8.6×10^{-4}	7.6×10^{-3}	7.9×10^{-2}	3.5
G	11	3.9×10^{-4}	7.6×10^{-4}	3.8×10^{-3}	4.5×10^{-2}	2.3

Most of the previous studies estimated particulate exposure by measuring the total mass concentration; very few studies investigated the particulate exposure with respect to particle size on agricultural farms. The size of particles, however, affects their respiratory deposition, resulting in different types of health effects (Lee et al., 2006). Our study gives information concerning five different sizes and this information permit to obtain more detail information concerning particles contamination and possible health effects.

Our data showed higher values in PM5 and, predominantly in PM10, indicating that swine dust can penetrate into the gas exchange region of the lung (PM5) and may also produce disease by impacting in the upper and larger airways below the vocal cords (PM10) (Vincent and Mark, 1981).

Wathes and colleagues (1998) found that the inhalable dust emissions from pig buildings were forty per cent higher in summer than winter, while respirable dust emissions were not affected greatly by the season. Considering this aspect we can point out that there is a possibility that PM10 values can be even higher in the summer time

In a European project developed in England, the Netherlands, Germany, and Denmark with stationary measurements in 256 animal buildings mean value for inhalable dust in pig buildings were 2.19 mg.m^{-3} (Seedorf, 1998; Takai, 1998, 1999; Iversen et al. 2000). Three (B, D and F) of our seven farms studied obtained higher mean values.

In a study developed by Donnell and colleagues (2008) in five Irish swine farms was found the same tendency with respect to particles size distribution, namely a median value of 2.99 mg.m^{-3} for inhalable and 0.19 mg.m^{-3} for respirable dust (Donnell et al., 2008).

The amount of dust in the air of livestock buildings is correlated to environmental factors such as ventilation, feeding practices, bedding materials, dung and slurry handling, and animal activity (Takai and Pedersen, 2000). A well designed and managed ventilation system will control the levels of gases, dusts and vapours, and is an important factor in controlling odours from swine confinement buildings (Chastain, 2000). The absence of a ventilation system in B and D farms can contribute to explain the higher results obtained, particularly in PM5 and PM10.

4. CONCLUSIONS

Results demonstrate high levels of contamination by particulate matter in swine farms studied, particularly PM5 and PM10 sizes. The evidence of respiratory disease in this occupational setting documented in many studies supports the need for development of workplace health protection programmes.

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