ORAL PRESENTATIONS

REDUCING THE CONCENTRATION OF AIRBORNE PARTICLES IN HORSE STABLES

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SUMMARY

Horses appear to be more sensitive to airborne particles than other species of livestock and high concentration of airborne pollutants in horse stables reportedly interfere with the health and athletic ability of these animals. In order to develop best practice management procedures, the effects of three different bedding material treatments on the resultant air quality were assessed during an experiment and compared to "standard" sawdust bedding (control). The effects of (1) sawdust impregnated with canola oil, (2) straw bedding and (3) the use of "horse-nappies" on the concentration of airborne particles inside four horse stables were studied, using a 4x4 Latin Square experimental design. The results demonstrated a significant reduction in the concentrations of inhalable and respirable airborne particles in the horse boxes treated with oil-impregnated bedding material. This technique would enable horse keepers to improve the environmental quality of horse stables at a relatively low cost.

Keywords: horses, air quality, stables, environment, oil impregnation, bedding material

INTRODUCTION

Adequate air quality, including low airborne particle concentrations in stables is an important component of good horse husbandry (Blunden *et al.* 1994; Carpenter 1986; Woods *et al.* 1993). Horses are sensitive to airborne particles and a strong association has been demonstrated between airborne pollution and respiratory diseases in horses (Christley *et al.* 2000; Clarke & Madelin 1987). Poorly managed horse stables with high airborne particle concentrations may affect the animals' respiratory health as well as the health of stable workers (Gruys *et al.* 1994). Horses in countries with colder climate are routinely stabled for a large part of the day so the maintenance of acceptable air quality becomes an important aspect of good stable management (Mathews & Arndt 2003). In addition, horses are kept in buildings for extended periods over many years and thus the length of exposure to airborne pollutants is significantly greater than for food animals (Clarke & Madelin 1987; Vandenput *et al.* 1998). Therefore, appropriate airborne particle reduction methods have to be an integral part of routine stable management (Clarke & Madelin 1987; Dunlea & Dodd 1997). To facilitate the wider adoption of particle reduction techniques, a series of experiments have been conducted in South Australia to evaluate the effects of different

management strategies aimed at reducing airborne particle and other airborne pollutant concentrations in horse stables.

MATERIAL AND METHODS

The specific objective of the study was to assess the effects of three different bedding treatments on the resultant air quality using controlled experiments. The effectiveness of these treatments was evaluated by comparing the air quality parameters with corresponding data obtained in a "standard" sawdust bedded stable (control). The effects of (1) sawdust impregnated with canola oil at the inclusion rate of approximately 7% (weight/weight), (2) straw bedding and (3) "horse-nappies" (that prevents the bedding material to be contaminated with faecal material) on the concentration of airborne particles inside four horse stables were studied, using 4x4 Latin Square experimental design over four weeks. The advantage of the Latin Square design is that it effectively controls for different sources of variation that may possibly increase experimental errors (Chen & Chen 1999; Demidenko & Stukel 2002; Tukey 1997). The boxes were cleaned between experiments to avoid any carry over effects from previous treatments. Each box received the treatment for a week and then the treatments were re-allocated randomly.

Table 1. Experimental design for the horse trial

Week	Horse box A	Horse box B	Horse box C	Horse box D
1	Straw treatment*	Control	Oil treatment	Nappy treatment
2	Oil treatment	Nappy treatment	Straw treatment	Control
3	Control	Straw treatment	Nappy treatment	Oil treatment
4	Nappy treatment	Oil treatment	Control	Straw treatment

*Straw treatment: straw bedding, without nappy and without oil spraying; Oil treatment: saw-dust bedding, without nappy and with oil spraying; Control: saw-dust bedding, without nappy and without oil spraying; Nappy treatment: saw-dust bedding, with nappy and without oil spraying

Air quality parameters were recorded for 28 days in the four naturally ventilated horse boxes housing one horse each. Airborne inhalable and respirable particles, carbon dioxide, humidity and temperature were measured as previously described in detail by Banhazi et al (2004). In brief, temperature and humidity data were recorded using Tinytalk temperature and humidity loggers (Hasting Dataloggers, Tinytalk-2). 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) were operated at 1.9 and 2.0 l/min flow rate, respectively. Dust pumps were operated from 09.00 to 15.00 hours. Carbon dioxide was monitored using Multi-gas Monitoring Machines to confirm that ventilation rates were similar in the boxes and to measure ammonia levels (Banhazi *et al.* 2005). The air quality data was analysed using GLM procedure in SAS and parameters were compared between the treatments.

RESULTS AND DISCUSSION

Temperature and the concentration of carbon dioxide did not vary significantly throughout the experiment but there was a statistically significant ($p=0.006$) reduction in the concentration of

inhalable particles (Table 2). On average, inhalable particle concentrations were the highest for the "Straw" followed by the "Control" treatments. The "Nappy" and "Oil" treatments gave the lowest concentrations of inhalable particles and the difference between these two treatments was not significant.

Table 2. Temperature and the concentrations of inhalable airborne particles and carbon dioxide for the control and treatment boxes.

Treatment	Temperature (^oC)	Inhalable dust (mg/m^3)	Carbon dioxide (ppm)
Control (saw dust)	22.2[a]	0.397[a]	499[a]
Straw bedding	22.5[a]	0.606[b]	488[a]
Horse-nappy	22.2[a]	0.287[c]	508[a]
Oil-impregnated saw dust	22.3[a]	0.298[c]	504[a]

[ab] Values in the same column with different superscripts differ significantly ($P<0.05$).

Respirable particle concentrations were also positively affected by the treatment, but only in interaction with the "Day" effects (Figure 1).

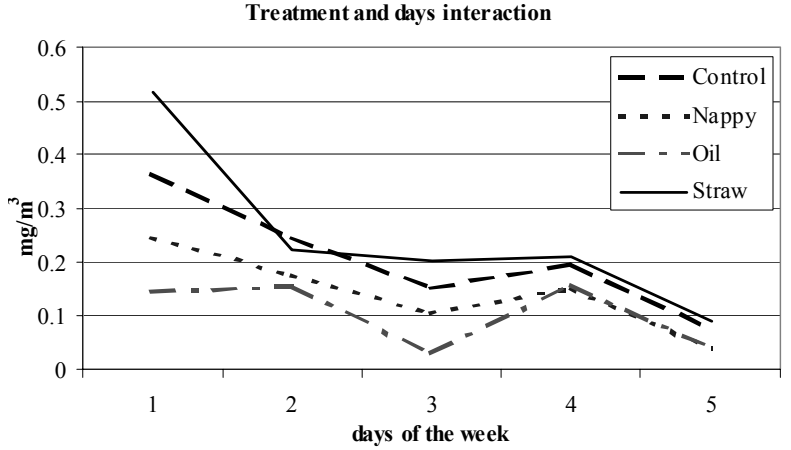

Figure 1. The effects of treatment and day interaction on respirable particle concentrations (mg/m^3)

The interaction was mainly influenced by the readings from the first day of the weekly measurements. On the first day of the week (Monday) there was considerable variation between the treatments with the "Straw" treatment having the highest readings of respirable dust (Figure 1). This variability or difference between treatments decreased over the subsequent measurement days. However, as an overall trend it can be seen from the graph that the highest concentrations of respirable particles were recorded for the "Straw" and "Control" treatments compared with "Nappy" and "Oil" treatments. The "Oil" treatment gave the lowest concentrations of respirable particles, compared to all other treatments (Figure 1).

Differences between relative humidity readings were also highly significant ($p < 0.001$), indicating that adjusting for this co-variate within the analysis was important (Figure 2).

Treatment and Day effects significantly interacted (p=0.041) for this variable (Figure 2). Relative humidity on average increased over the 5-day measurement period for "Oil" and "Control" treatments, but decreased for the "Nappy" treatment over the experimental days. This is likely to be due to the horse nappy preventing contamination of the bedding material with faecal matter.

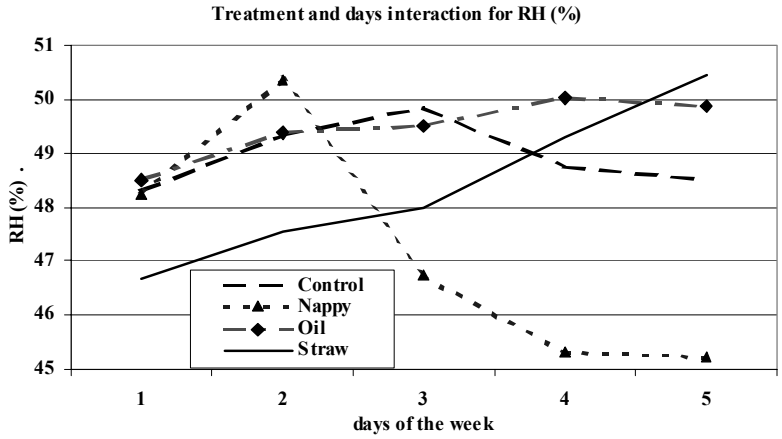

Figure 2. The effects of treatment and day interaction on relative humidity (RH, %)

These results demonstrate a significant reduction in the concentrations of inhalable and respirable airborne particles in horse boxes using either oil-impregnated bedding material or horse nappies can be achieved. These techniques would enable horse keepers to improve the environmental quality of horse stables at a relatively low cost. However, further studies are needed to determine the best method of incorporating oil into the bedding material, the minimum concentration of oil necessary and the effects of oily bedding material on the health and wellbeing of the animals.

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