CONTROLLING THE CONCENTRATIONS OF AIRBORNE POLLUTANTS IN POULTRY BUILDINGS

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SUMMARY

The objective of the project was to assess the efficiency of an oil treatment applied to the bedding material in broiler buildings in order to improve air quality. A classical comparative experiment was conducted during the winter season on a commercial farm. Bedding in a broiler building was treated with a mixture of oil/water, while the other identical building was used as control. Air quality parameters were measured in the building using standard measuring techniques. The oil treatment significantly ($p<0.001$) reduced the concentrations of both inhalable and respirable particles in the treatment room. However, the mortality rate in the oil treated building was 6.59% compared to the control room of 3.83%, which would require further investigation.

Keywords: poultry, air quality, spraying, reduction, emission, ammonia, dust

INTRODUCTION

The present economic climate of poultry production forces producers to focus on improving efficiency. One of the important factors in achieving improved efficiency is the provision of an optimal building environment (Backstrom *et al.* 1994). Optimal environment encompasses good air quality including gas, particles and microbial concentrations as well as controlled temperature, humidity and ventilation rates (Wathes *et al.* 1991; Wathes *et al.* 1983). An improvement in air quality within poultry buildings should enhance production efficiency and health of birds (Almond *et al.* 1996) as well as reduce OH&S related health problems in humans (Donham et al. 1989). The litter is a major source of particles in poultry houses and its characteristics would affect airborne particle concentrations. Therefore, the most likely factors, which can be controlled to achieve a reduction in the concentration of airborne particles in poultry buildings, are the quality and characteristics of the bedding material. The aim of the project presented here was to conduct experiments to assess a strategy aimed at improving air quality in poultry buildings and therefore the sustainability of the farming operation. It was hypothesised that dramatic airborne particle reduction could be achieved by sprinkling oil directly onto the litter. It was expected that this treatment would modify the properties of the litter, making smaller, potentially airborne particles stick to the large bedding particles and therefore reduce the opportunities airborne particle generation (Drost et al. 1999).

MATERIAL AND METHODS

A classical comparative experiment was conducted during the winter season in 2002 in South Australia. Two identical and environmentally controlled broiler buildings (approximate size of 370 m^2) on the same poultry farm were selected for the experiment and chopped straw was used as litter material in both buildings. The bedding material in one of the buildings was treated with the oil/water mixture, while the other building stocked at the same rate was used as control building. Male meat birds were placed in the buildings at the same time and were stocked at 15.9 birds/m^2. The light program was a continuous ten hours dark period from 5 p.m. to 3 a.m. The incorporation rate of oil was based on the results of the preliminary shaker-box trial (Banhazi *et al.* 2002). The quantity of oil used represented approximately 7.5% of the weight of the bedding material. The treatment was applied after the chopped straw was spread inside the buildings and before the birds were introduced. Canola oil, water and surfactant (emulsifier) were mixed in a drum at the ratio of 8:4:1. The water was incorporated at a minimum rate to prevent excessive wetting of the litter, however some water was necessary to facilitate spraying of the mixture. The high viscosity of the oil made it difficult to use any low-pressure spraying instrumentation for the delivery of the oil treatment. The mix was poured into a backpack-spraying unit containing 16 litres of the mixture and sprayed directly onto the litter that was then raked to homogeneously spread the mix.

The day after the oil treatment, wire cages were positioned in the middle of both buildings to protect the measuring devices, which were deployed within these cages in both the buildings. Temperature and humidity sensors were used to collect both internal and external humidity/temperature data. The inhalable and respirable particles concentration inside the buildings was measured twice a week, for the duration of the study utilising the standard gravimetric method (Banhazi *et al.* 2004). The dust pumps were operated over a 6-hour period, using programmable timers. The sampling periods were set from 10 am to 4 pm every Tuesday and Thursday to coincide with the highest level of activity expected in the buildings. Ammonia and carbon dioxide were monitored continuously using a multi-gas monitoring machine in each building (Banhazi *et al.* 2005). The producer recorded mortality per building every day. A General linear Model (GLM) (Statistica 6.0) was developed to determine the effects of the oil treatment on inhalable and respirable airborne particles concentrations, considering age of birds and other environmental covariates such as internal humidity and temperature. The GLM developed to determine the effect of oil treatment on ammonia concentration incorporated, internal humidity, internal temperature, bedding temperature and CO_2 concentrations as covariates.

RESULTS AND DISCUSSION

Figures 1 show the mean concentrations of inhalable and respirable airborne particles in the treatment and control rooms. The oil treatment significantly ($p<0.001$) reduced the concentrations of both inhalable and respirable particles in the treatment room, which confirmed the effect of oil treatment demonstrated in previous studies (Banhazi *et al.* 1999; Feddes *et al.* 1995).

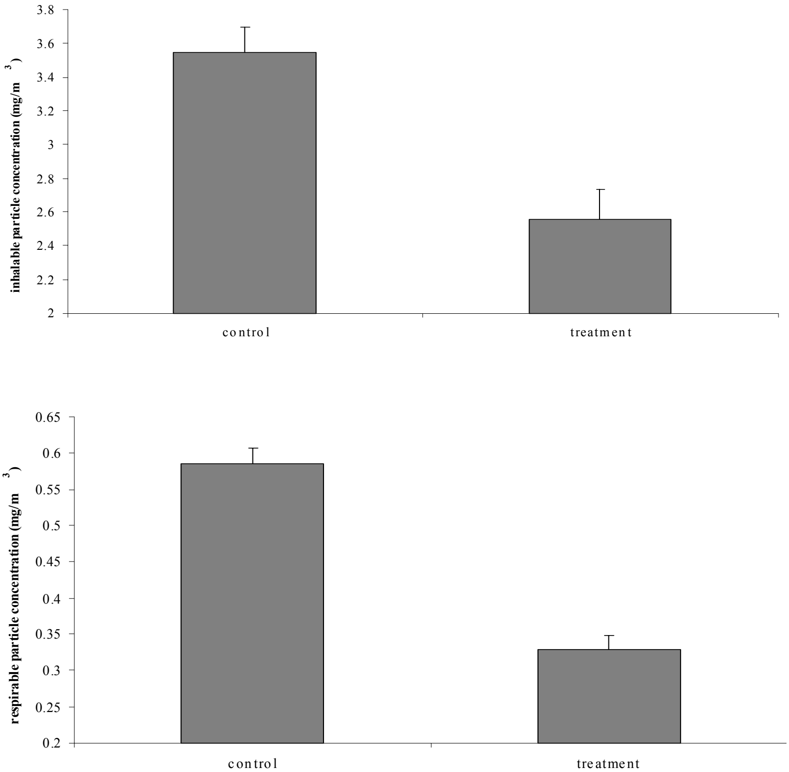

Figure 1. The LS mean (± SE) inhalable and respirable particle concentrations in control and trial buildings

The age of birds also had a significant effect on inhalable particles concentration ($p<0.05$) but not on respirable particles. The inhalable particles concentration increased with the age of birds, which agreed with previous studies (Hinz & Linke 1998; Madelin & Wathes 1989; Renault 1997). The internal temperature significantly ($p<0.05$) affected the respirable particles concentration although it was not statistically significant for the inhalable particles concentration.

A significant reduction in ammonia concentration ($P<0.001$) was also demonstrated in the treatment room. Figure 2 shows the mean ammonia concentration in control and trial rooms. A reduction of ammonia concentrations with the same type of oil treatment was reported in piggery buildings (Zhang 1997). The effect of the oil treatment on ammonia was not demonstrated in previous studies in poultry buildings (Feddes et al. 1995). One possible explanation for the positive effect demonstrated in this study is that the oil treatment might interfere with the bacteria flora in bedding responsible for ammonia generation from nitrogenous compounds, thus decreasing the ability of bacteria to generate ammonia. Despite the fact that the reduction of ammonia concentrations has not been fully explained, this finding was an important result because high ammonia levels are not advantageous for poultry production.

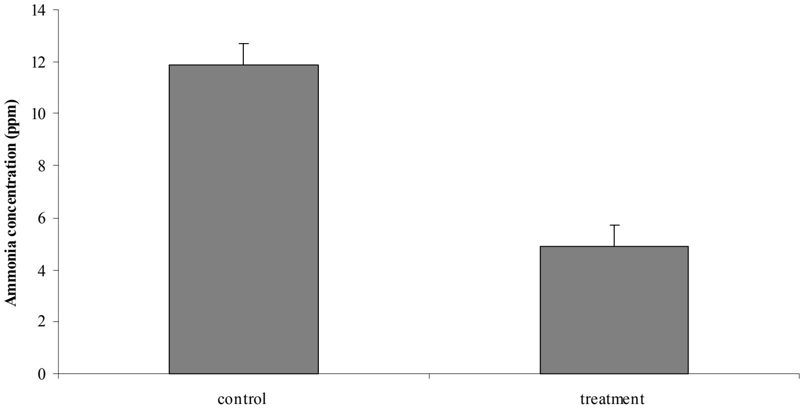

Figure 2. LS Mean (± SE) ammonia concentrations in control and treatment buildings

Practical aspects and mortality

This application has to be made more practical via associated engineering developments, as the experimentally used manual spraying and raking is not practical under commercial conditions. In the future the oil can be directly incorporated into the bedding material during the processing of the straw. It would be easy to set up a small sprayer machine on the conveyer belt that carries the chopped straw inside the building. According to the collaborating producer, the reduced airborne particle generation from the bedding material during the spreading of the straw was another beneficial aspect of the trial. The spreading of the bedding material is normally associated with high airborne particle concentrations and the reduction of airborne particles during that time most likely had a major beneficial effect on worker safety and respiratory health.

After the application of the oil mixture, casual observation indicated that birds were as active scratching the bedding in the control building as in the experimental building. Therefore, the oil treatment appeared not affect the comfort characteristics of the bedding for the young birds. Moreover the plumage of the birds was not greasy. Greasy plumage could cause heat loss in birds reported in other studies (McGovern *et al.* 2000). The overall cost associated with the treatment of the trial building (80 litres of oil and 10 litres of surfactant applied) was \$166 or AU\$ 0.45/m^2. The mortality rate in the oil treated building was 6.59% compared to the control room of 3.83%. In previous studies with the application of oil treatment to the litter in poultry buildings, no adverse effect on mortality was demonstrated (Feddes *et al.* 1995; McGovern *et al.* 1999). However, the increased mortality observed in this study, warrant further investigation.

Overall, the study conducted have demonstrated that airborne particle and ammonia concentration can be significantly reduced in broiler buildings (using straw bedding) by impregnating the litter with a relatively small amount of canola oil, once before the birds enter the building (Banhazi *et. al.*, 2003). The demonstrated (and unexpected) significant reduction in ammonia indicated, that this technology could potentially be used to reduce ammonia emissions as well.

CONCLUSION AND IMPLICATIONS

The high particle concentrations found in poultry buildings motivated researchers to experiment with this particle reduction technique under Australian climatic conditions. The application of an oil/water/emulsifier mixture directly onto the litter at the beginning of a batch of broilers; (1) significantly reduced the concentrations of inhalable and respirable airborne particles and (2) ammonia. However, the apparent higher mortality in the treatment group is noteworthy and may warrant further investigation.

This particle reduction technique demonstrated its efficiency in terms of improving the indoor air quality and it can be also assumed the occupational health and safety (OH&S) conditions were better for the producers as a result of the treatment. In addition, the reduction of particle levels indoors will also reduce particle emissions. The future adoption of particle reduction strategies in the intensive livestock production industry and particularly in poultry buildings is important, due to the increasing environmental and occupational health and safety requirements. The oil impregnation method, utilised during this experiment, appears to be useful and practical. However, further experiments will be needed to assess the potentially beneficial effects of particle reduction on production efficiency, which will encourage poultry producers to apply this technique.

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REFERENCES

Almond, G., E. Roberts, and W. Hevener. 1996. How disease slows growth. Proceedings of the North Carolina Healthy Hogs Seminar. NC Pork Report, USA.

Backstrom, L., B. Algers, J. Nilsson, and I. Ekesbo. 1994. Effects of sow housing systems on production and health. Page 427 in P. Poomvises, and P. Ingkaninun, editors. Proceedings of the 13th International Pig Veterinary Society Congress, Bangkok, Thailand.

Banhazi, T., C. Cargill, N. Masterman, and J. Wegiel. 1999. The effects of oil spraying on air quality in a straw based shelter. Page 28 in P. D. Cranwell, editor. Manipulating Pig Production VII. Australasian Pig Science Association (APSA) Warribee, Victoria, Australia, Adelaide, Australia.

Banhazi, T., T. Murphy, and C. Cargill. 2002. Evaluating oil inclusion rates for bedding materials. Page 378 in D. K. Revell, and D. Taplin, editors. Animal Production in Australia. ASAP, QLD, Australia, Adelaide, South Australia.

Banhazi, T., J. Seedorf, D. L. Rutley, and D. Berckmans. 2004. Instrumentation kit for measuring airborne pollutants in livestock buildings. Pages 215–217 in F. Madec, editor. Proceedings of ISAH Conference. ISPAIA, St Malo, France.

Banhazi, T. M., J. Seedorf, D. L. Rutley, and W. S. Pitchford. 2005. Statistical modelling of gas concentrations in Australian piggery buildings. Pages 64–71 in T. Brown-Brandl, editor. ILES. ASAE, St Joseph, MI, Beijing, China.

Donham, K. J., P. Haglind, Y. Peterson, R. Rylander, and L. Belin. 1989. Environmental and health studies of farm workers in Swedish swine confinement buildings. British Journal of Industrial Medicine **46**: 31–37.

Drost, H., N. Beens, B. Dolehghs, H. Ellen, and H. H. E. Oude Vrielink. 1999. Is fogging of water or oil effective in reducing dust concentrations in poultry houses? Pages 231–236 in S. Pedersen, editor. Dust Control in Animal Production Facilities. Danish Institute of Agricultural Science, Scandinavian Congress Center, Aarhus.

Feddes, J. J. R., K. Taschuk, F. E. Robinson, and C. Riddell. 1995. Effect of litter oiling and ventilation rate on air quality, health and performance of turkeys. Canadian Agricultural Engineering **37**: 57–62.

Hinz, T., and S. Linke. 1998. A comprehensive experimental study of aerial pollutants in and emissions from livestock buildings. Part 2: Results. Journal of Agricultural Engineering Research **70**: 119–129.

Madelin, T. A., and C. M. Wathes. 1989. Air hygiene in a broiler house: Comparison of deep litter with raised netting floors. British Poultry Science **30**: 23–37.

McGovern, R. H., J. J. R. Feddes, F. E. Robinson, and J. A. Hanson. 1999. Growth performance, carcass characteristics, and the incidence of ascites in broilers in response to feed restriction and litter oiling. Poultry Science **78**: 522–528.

McGovern, R. H., J. J. R. Feddes, F. E. Robinson, and J. A. Hanson. 2000. Growth, carcass characteristics, and incidence of ascites in broilers exposed to environmental fluctuations and oiled litter. Poultry Science **79**: 324–330.

Renault, P. 1997. Caracterisation de l'air ambiant dans les elevages avicoles par l'analyse de trois parametres (poussiere, flore totale aerobie, ammoniac). Page 110. ISA, memoire de fin d'etudes.

Wathes, C. M., H. E. Johnson, and G. A. Carpenter. 1991. Air hygiene in a pullet house: Effects of air filtration on aerial pollutants measured *in vivo* and *in vitro*. British Poultry Science **32**: 31–46.

Wathes, C. M., C. D. R. Jones, and A. J. F. Webster. 1983. Ventilation, air hygiene and animal health. The Veterinary Record **113**: 554–559.

Zhang, Y. 1997. Sprinkling oil to reduce dust, gases and odor in swine buildings. Page 8. Midwest Plan Services (MWPS), Iowa State Univ. Ame, IA.