INHALABLE AND RESPIRABLE DUST IN WORK PLACE ATMOSPHERES OF LAYING HEN HOUSES

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Introduction

The air in modern livestock buildings contains varying amounts of aerial pollutants such as gases, dust and micro-organisms, also addressed as bio-aerosols, which can be harmful for the health of the animals and people working in this atmosphere (RADON et al., 2002). Particularly high amounts of dust (TAKAI et al., 1998) and micro-organisms (SALEH et al., 2003) are found in laying hen house air. It is assumed that nearly 15 % of all farmers working in laying hen houses complain about respiratory health disorders such as asthma, asthma like syndrome, chronic bronchitis, mucous membrane irritation and organic dust toxic syndrome (ODTS) (NOWAK 1998). Little is known about the concentrations of airborne dust, which can carry micro-organisms and gases such as ammonia, in the recently introduced new animal-friendly (alternative) aviary and enriched cage systems.

This paper compares the concentrations of the inhalable dust and respirable dust fraction in the air of a conventional cage system, an enriched cage and an aviary system and relates the dust levels to German occupational health limits (OHL), the so called MAK values (maximum concentrations at the work place).

Material and Methods

The investigations were carried out in three different types of laying hen houses of the laying hen research centre on the Experimental Farm Ruthe of the University. 1533 birds were kept in groups of ten to thirty animals in a three tier system of so called enriched cages (AK), type Aviplus (Fa. Big Dutchman, Vechta). Each cage was equipped with perches, a separate laying area and a dust bath. A floor area of 750 cm² per bird was provided. The second animal house was equipped with conventional four tired battery cages for 1345 animals providing 600 cm² per bird. The third animal house was built as an aviary where the 2304 birds can roam freely on three tiers and reach food and water in each of the three levels. The alleys are covered with litter for scratching. Along the walls nest boxes are installed. The birds have access to an outdoor scratching area which is littered with straw. This area was open for the animals daily after laying period. For more details see BRIESE et al. (2001). All birds were of a special layer breed called ,,Silver,, delivered by Fa. Lohmann, Cuxhaven from the same parent flock at the same day.

Measurements were carried out during the course of one year every second Monday each month over a period of 24 h between 6.00 h a.m. and 6.00 h a.m. the next day. In each of the three buildings two sampling positions were defined for the sampling heads of inhalable and respirable dust. These places were draught free, easy to reach for installation, out of the reach of the animals and as far as possible representative for air composition. The seventh sampling point was outside the building in a distance of about 20 m to take samples in the ambient air. The eight sampling place was set up in the outdoor scratching area. All sampling heads were installed about 1.5 to 1.6 m above the floor which represents approximately the breathing height of adult humans. The 24 h sampling period was chosen to eliminate short term variations of the dust concentration and give a broader base in the direct comparison of the three animals houses. In this paper average and minimum/maximum values are given only.

Inhalable dust was sampled by IOM heads (Institute of Occupational Medicine, Edinburgh), respirable dust by SKC cyclones (Blandfort Forum, UK) on glass fibre filters (Whatman, UK). The cyclones have a 50% cut off effectiveness for particles < 5 µm. The air was sucked through the sampling heads by sufficiently strong pumps. The flow rates were adjusted by help of critical jets to 2 l/min (IOM) and 1,9 l/min (SKC). The filters were conditioned in a climate chamber at 23 °C$\pm$ 2 and 45$\pm$ 5 % relative humidity before sampling and before weighing. In the same room the weighing took place (balance Sartorius AG, Göttingen). The dust concentration was calculated by air volume and the weight difference before and after sampling and is given in mg/m³.

Results

Table 1 shows the average concentrations of the inhalable dust in the three animal houses, in the scratching area and in the ambient air obtained by 12 measurements at each place. The highest concentrations were found in the aviary followed by the battery cages and the enriched cage system. Distinctly lower concentrations are reached in the outside scratching area and at the sampling position which should represent ambient air quality. and with peak concentrations of about 0.1 mg/m³. In rural regions total dust concentrations of about 40 µg/m³ are common. This corresponds to the average value at this sampling place.

Tab. 1: Mean inhalable dust concentrations in mg/m³ and minimum and maximum values at different sampling places inside and outside the laying hen houses. No. of measurements n = 12. n.m. = not detectable.

ANIMAL HOUSE	MEAN VALUES	MINIMUM	MAXIMUM
Enriched cage	**0,8**	**0,44**	**1,32**
Battery cage	**1,**	**0,24**	**2,05**
Aviary	**3,8**	**1,20**	**9,50**
Scratching outside	**0,3**	**0,01**	**1,09**
Ambient air	**0,04**	**n. d.**	**0,10**

Highest concentrations were measured in the aviary system. The total dust can reach at certain times average concentrations of 9.5 mg/m³ over 24 h periods which is more than double than the occupational health threshold for an eight hour working day. The 24 h average total dust concentrations in the caged systems are distinctly lower. The variations in concentration are particularly high in the scratching area which is caused by the different activity phases of the animals.

Figure 1 explains the differences between the animals houses and to the ambient air in greater detail and shows the large standard deviations which are associated with such measurements. With 3.8 mg/m³ of total dust as an average value all over the year, the pollution of atmosphere in aviaries is permanently close to the occupational health threshold of 4.0 mg/m³ (MAK, 2003). The results show that there is a need to improve air quality in aviary systems in order to protect the health farmers.

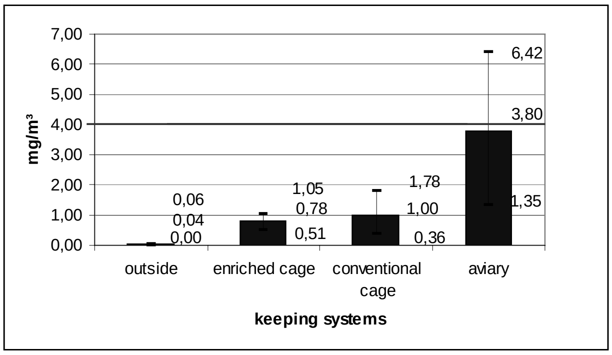

Fig. 1: Mean inhalable dust concentrations (incl. s.d.) in three different laying hen housing systems and in the ambient air close to the building. n = 12.

In **Table 2** the figures for the respirable dust are given. The highest concentrations of total dust are again observed in the aviary system. Concentrations of more than 4 mg/m³ are found during some 24 h measurements. The ratio between the highest and the lowest concentrations is about 10. Distinctly lower concentrations were found in the battery cages and the enriched cage system. The minimum values are similar whereas the maximum values differ considerably.

Tab. 2: Mean respirable dust concentrations in mg/m³ and minimum and maximum values at different sampling places inside and outside the laying hen houses. No. of measurements n = 12. n.m. = not detectable.

ANIMAL HOUSE	MEAN VALUE	MINIMUM	MAXIMUM
Enriched cage	**0,33**	**0,23**	**0,62**
Battery cage	**0,66**	**0,21**	**1,09**
Aviary	**1,93**	**0,40**	**4,40**

The extent of the standard deviations can be seen in **Figure 2** where the concentrations of respirable dust found in the three laying houses is compared to the occupational health threshold. It is remarkable that the average value across all 12 measurement campaigns (1,93 mg/m³) is distinctly above the occupational health threshold of 1.5 mg/m³ (MAK, 2003).

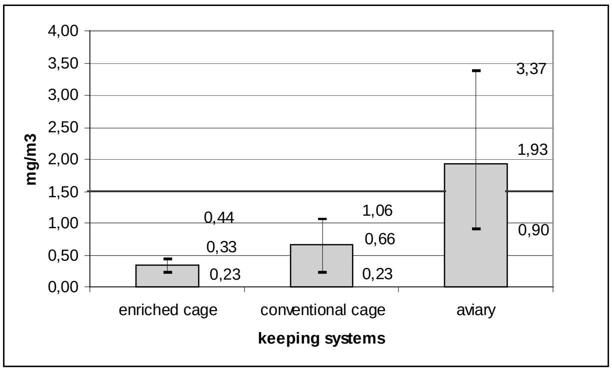

Fig. 2: Mean respirable dust concentrations (incl. s.d.) in three different laying hen housing systems. n = 12.

Diskussion

The results of this survey show that the concentration of airborne dust in laying hen houses decisively depends on the type of the keeping system. The investigations were carried out under management practices which were typical and common for these types of laying hen houses. Dust concentrations (inhalable and respirable) above occupational health thresholds were found in the aviary system where the animals can move freely and have permanent access to litter on the floor. The high average values indicate that these thresholds are exceeded regularly. Considering that the presented results are means over 24 h measuring periods which included the resting times at night, it can be assumed that the concentrations during the day when the staff is working in the animal house, the atmosphere is even higher polluted by dust particles. There is an urgent need for more investigations how to reduce the air pollution particularly in alternative laying hen housing systems for the protection of the health of the farmer, for the animals which live permanently in this atmosphere and also for the outside environment in which the pollutants are emitted and distributed by the exhaust ventilation system. As a first measure, farmers should be advised to carry filter masks in aviary and similarly constructed laying hen housing systems.

References

Briese, A., Sewerin, K., Knierim, U., Hartung, J. (2001): Ausgestaltete Käfige in der Legehennenhaltung – rechtliche Rahmenbedingungen und Ansatzpunkte für ihre wissenschaftliche Beurteilung. Dtsch. tierärztl. Wschr. 108, 105-109

MAK (2003): MAK und BAT-Werte-Liste. Mittl. 39. DFG Senatskommission. Wiley-VCH Verlag GmbH, Weinheim. p. 232.

Nowak, D. (1998): Die Wirkung von Stalluftbestandteilen, insbesondere in Schweineställen, aus arbeitsmedizinischer Sicht. Dtsch. tierärztl. Wschr., 105, 225-234.

Radon, K., et al. (2002): Prevalence and risk factors for airway diseases in farmers – summary of results of the European farmers´ project. Ann Agric Environ Med 9, 207-213

Saleh, M., Seedorf, J., Hartung, J. (2003): Total count of bacteria in the air of different laying hen housing systems. (Orig German, English abstract) Dtsch. tierärztl. Wschr., 110, 349-400

Takai, H., et al. (1998): Concentrations and Emissions of Airborne Dust in Livestock Buildings in Northern Europe. Journal of Agricultural Engineering Research, 70, 59-77

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