Torsten Hinz, Hans Sonnenberg, Stefan Linke and Jennifer Schilf, Braunschweig and Jörg Hartung, Hanover

Dust reduction through moistening of straw when bedding a cattle building

Keeping cattle on bedding is once again in demand, mainly in cold and naturally ventilated housing. Most often, straw is used as a litter suitable for animal welfare. One problem with this is the emissions of airborne dust particles which can negatively affect breathing with humans and livestock, especially as the presence of endotoxins has also been proved. As a possible strategy to reduce this, the use of particle-binding moisture seems appropriate. In trails, water was applied in different ways. It was thus possible to reduce total dust and endotoxin concentrations by over 90% without affecting the function of the litter.

Dr.-Ing. Torsten Hinz and Stefan Linke are staff members of the Institutes for Technology and Biosystem Technique at FAL, Brunswick, Dipl.-Ing. Dipl.-Ing. Hans Sonnenberg and Jennifer Schilf are staff members at the Institute for Farm Technology and Building Research at FAL, Brunswick; e-mail:hans.sonnenberg@fal.de
Prof. Dr. Jörg Hartung is director of the Institute for Animal Hygiene and Animal Welfare, Veterinary University of Hanover.

Keywords

Dust reduction, endotoxins, cattle housing

Literature details are available from the publishers under LT 00419 or via Internet at http://www.landwirtschaftsverlag.com/landtech/local/fliteratur.htm.

The use of straw as litter in cattle housing has increased once again over about the last 10 years. Straw is good for animal welfare and appears to positively influence the comfort and health of the livestock. Alongside work economy aspects, the disadvantages are the stress on humans and animals caused by dust rising from the straw, set free mainly during bedding but also through the activities of the livestock. Along with the dust, other material particles such as microorganisms and endotoxins become airborne. These can cause breathing-passage problems with humans working in the housing and with livestock [1,2]. Thus, ways are being sought to minimise dust development in livestock housing [3,4]. Here, however, there is the difficulty of carrying out a representative dust measurement in the comparison of two houses or two types of litter, because in the period of a day, substantial variations in concentrations can appear[5,6,7].

Investigations oriented to dust reduction through moistening straw before and during bedding took place in sloping floor solid dung housing. This was chosen as trial site because in this system an especially high dust content can be expected compared with,e.g., deep straw bedding systems [7], so that the efficacy of reduction methods can be seen especially clearly. The measuring position was situated in an area where humans tend to be located in the housing passage that the stress on the humans working in the housing could be accurately represented. Attention was also paid to the importance of carrying out the measurements only at times when ventilation air intake did not affect the readings. The interior air currents were checked to ascertain this.

Material and methods

At the time of the measurements the livestock house was occupied with 28 young cattle 27 months of age which represented a total occupation of 32.45 GV (GV = mature animal unit = 500 kg liveweight). Fig. 1 shows a diagram of the housing design and the position of the measuring point in the passageway. The laying areas have a 10% slope. Their area is 4.74 m(18.2 m = 86.45 m^2).

As litter, big rectangular bales of wheat straw were used. For trial purposes, some of the straw was prepared by spreading and moistening in the passageway and before being thrown onto the upper part of the lying areas. The following three actions were investigated:

1. Reducing the presence of dust: three layers of a 285 kg straw bale were at first spread out in the passage and sprayed with 4 l of water (0.014 l/kg) from a knapsack sprayer. The straw was then thrown onto the lying area.
2. Reducing dust during bedding: the straw was treated with water as in the first action and dust clouds appearing when the straw was thrown onto the lying area were sprayed by knapsack (0.10 l/kg). The aim was to form an aerosol with dust and water drops bound to larger units which then sink more rapidly.
3. The straw was treated with water in a feed mix wagon (54 l of water for 285 kg straw, 0.19 l/kg). The measurement of the total dust concentration took place with the help of a filtration unit with glass filters (high-volume collector 50 m3/h). This dust was used for endotoxin analyses.

The continuous measurement based on the working place was carried out on-line with

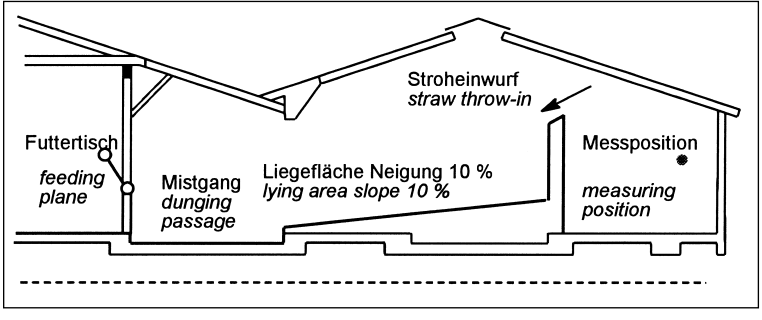

Fig. 1: Scheme of sloped floor housing

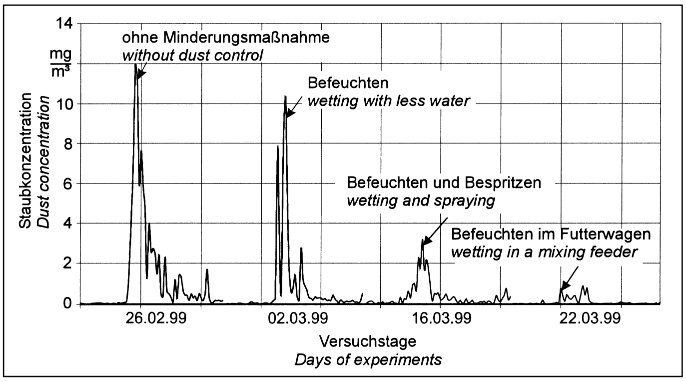

Fig. 2: Course of total dust concentration during littering without a dust reduction measure and various measures for dust reduction

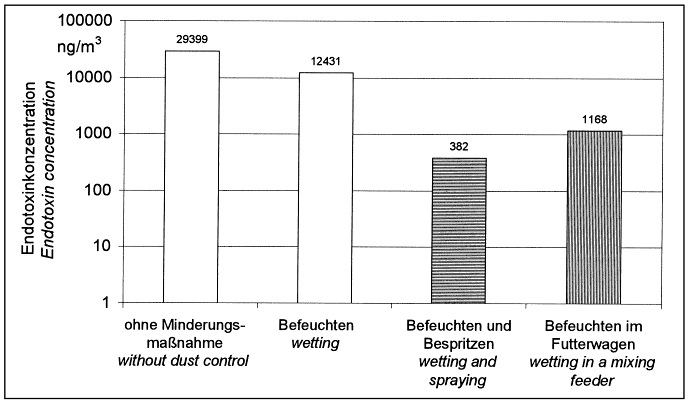

Fig. 3: Airborne endotoxins during littering without and with dust reduction measures

the instrument TEOM [8]. At the same time, actual concentration values were recorded out of the cumulative measurement results through difference formation. Measuring point height was 1.5 m, the suction velocity for sample air was 1.25 m/s. This represented the conditions with a human.

Before the application of the dust-reduction actions, control measurements were taken at the same point.

Results and discussion

The first measurements of the actual study were carried out without dust reduction actions in order to achieve a continuation with earlier investigations. These showed short-term peak concentrations of 12 mg/m^3 for total dust and 30,000 ng/m^3 for endotoxin presence during the litter spreading, similar to earlier measurements in cattle housing with deep straw bedding [7]. The quality of the straw and its dust production is influenced by many factors such as harvest and storage as well as the way the straw is handled by the worker (factor 2).

FIG. 2 depicts different procedure curves in comparison. Without any action to reduce dust, a concentration of up to 12 mg/m3 was reached whilst bedding. Only after around 90 minutes did the concentration return to the level before bedding began. Moistening the straw before bedding reduced the peak concentration by 2 mg/m3 to around 10 mg/m3 and after only around 45 min. the original levels were reached. If additional water was sprayed in the interior of the buildings to bind with the dust during bedding, the dust concentration at the measuring point reached 3 mg/m3. The period of heightened dust concentration lasted for around 30 min. The dust was efficiently bound with 54 l water. This water had to be sprayed throughout the around 15 min. long bedding period.

Moistening the straw in a feed mix wagon led to the least dust emission during bedding. The concentrations did not rise above 1 mg/m3. The period of lightly increased dust concentration was limited to 30 min. Water usage was once again 54 l (0.19 l/kg).

Fig. 3 compares the endotoxin concentrations in the air of the cattle house interior during bedding in association with the dust reduction actions. Even with straw moistening, the endotoxin concentrations were still recorded at over 12,000 ng/m3 interior air. The lowest endotoxin content (382 ng/m3) was measured when previously moistened straw was also sprayed with water during bedding. However, in the case of endotoxins, the moistening the straw in the feed mix wagon was not so successful as it was with dust reduction. All the same, compared with control and with moistened straw, this approach reduced endotoxin concentration more than tenfold. But the moistening and spaying action still resulted in endotoxin concentrations which lay clearly over the current concentrations in discussion as maximum amounts in working premises [9], whereby the importance of the relatively short explosion period has not yet been finally clarified. The general dust maximum concentration of 4 mg/m3 for the share that is inhaleable was exceeded for a short period in the "control" and "moistening" trials.

The trials indicated that the bedding action is especially associated with the releasing of considerable amounts of dust and other material such as, e.g., endotoxins. However, increased concentrations were only observed over a relatively short period of time with a maximum of one hour. Reduction methods such as the moistening of straw before bedding succeeded here in a certain reduction of peak concentrations as well as in the length of time of excess dust in the air. Bedding with moistened straw with simultaneous spraying of water in the air also held the peak-value under 4 gm/m3. The lowest concentration of endotoxins was also determined with this method. Moistening the straw in a feed mix wagon created the lowest dust emissions . The concentrations here remained slightly increased for a period of around 30 min. but were substantially under 1 mg/m3. However, the endotoxin concentrations lay clearly over the those recorded with the combined method comprising "moistening" and "spraying" . This indicates that endotoxins are present in the moist particles as well as the dry material. The function of bedding was not affected by water application. The labour-input involved would have to be reduced for practical conditions.

Conclusion

Even small amounts of water (0.014 l/kg) sprayed on straw before bedding reduced dust concentration at the measuring point in animal housing by 10% and the endotoxin content by 58%. If 0.10 l water/kg of straw was sprayed over the already moistened litter during bedding in order to bind the dust particles, dust reduction achieved was 75% and that for endotoxins 99%.