Edith Szabo and Wolfgang Büscher, Bonn, as well as Wolfgang Müller and Bert-André Zucker, Berlin

Relationship between Airborne Particles and Mould Spores in a Horse Barn

The different methods of determining airborne dust concentrations are less complicated and time consuming than those for detecting microorganisms. This holds true both for gravimetric dust measurements and online measurement instruments which measure continuously. Determining the actual situation in barns by estimating the amount of aerosolized microorganisms in situ is not practicable. A statistical model was used to determine the proportion of mould spores bound to dust particles for different sized classes. The relationship between the concentration of airborne particles and mould spores is shown using a regression analysis, which can roughly predict the mould content in barns through dust measurements.

Edith Szabo is a veterinarian and a postgraduate research student and Prof. Dr. Wolfgang Büscher is the head of the Institute of Agricultural Engineering of Bonn University, Nussallee 5, D-53115 Bonn, and of its 'Livestock Technology' section; e-mail: *edith.szabo@uni-bonn.de*
Prof. Wolfgang Müller is the former head of the Institute of Animal Hygiene and Environment Protection in the Department of Veterinary Medicine of the Free University of Berlin, Luisenstraße 56, D-10117 Berlin, and PD Dr. Bert-André Zucker is a scientific assistant at the same Institute.

Keywords

Dust particles, moulds, horses

The immediate environment of horses is limited mainly to their stables. Accordingly, horse keeping practice and barn management play an important role in keeping horses healthy. The actual situation in barns with regard to airborne particles can only be determined by means of online measurements. Long-term and point measurements in horse barns were intended as the basis for a detailed analysis of the relationship between airborne particles and moulds in order to be able to use in situ dust measurements for estimates of the mould content in the barn air. In addition to measurements carried out under practical conditions, the process of feeding roughage to horses was simulated on a laboratory scale using a standardised method, which employs a "dust releasing box" developed at Bonn University. The aim of this series of experiments was to achieve concentrations of airborne particles and moulds with as high a degree of homogeneity as possible.

Fig. 1: Dust releasing cube with a PGP-GSP and -FSP measuring apparatus and the climatic console

Material and Methods

The parameters dust and mould can be determined by various methods. A snapshot of the situation in the barn is only possible for particle number concentrations of airborne dusts [m-3], i.e. particles per volume unit, by using online measurement methods. The aerosol spectrometer manufactured by Grimm Aerosol Technik, Ainring (scattered light principle, 15 size classes) is a suitable instrument for this purpose. Mould concentrations were determined in long-term measurements using an eight-stage Andersen Cascade Impactor (impaction principle, air flow: 28.3 l/min). The fractionation of the particles into size classes simulates the deposition of inhalable dusts in the human respiratory tract. The particles deposited on the individual stages were processed and cultivated in the laboratory immediately after sampling. A PGP sampler (personal sampling system for dangerous substances) with a GSP sampler head (for total dust collection) and with a sampler head for fine particles (< 5 µm) was used in the point measurements for mould detection and in the experiments with the "dust releasing box" (filtration principle). The filtered dust was deposited on sterilised polycarbonate filters with a pore diameter of 0.8 µm and subsequently processed and cultivated in the laboratory.

Fig. 2: Test box in a horse barn

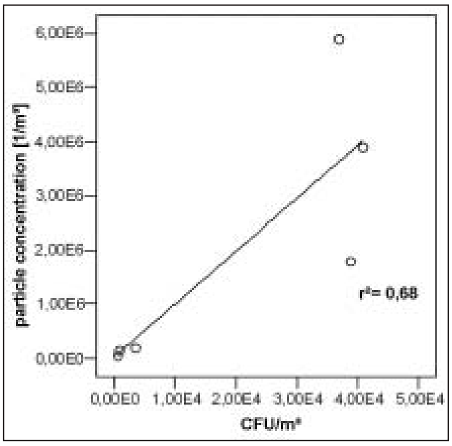

Fig. 3: Relationship between the total dust particles and the mould spores collected with the GSP in the selected measurements

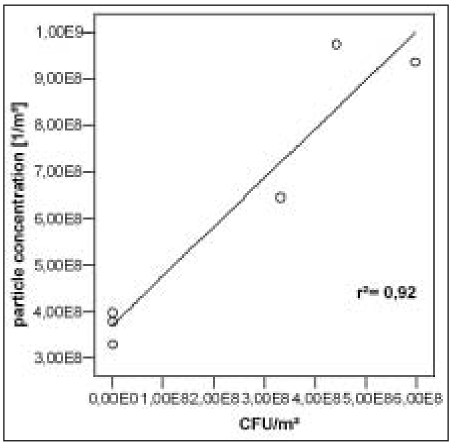

Fig. 4: Relationship between the total dust particles and the mould spores collected with the GSP in the dust releasing cube

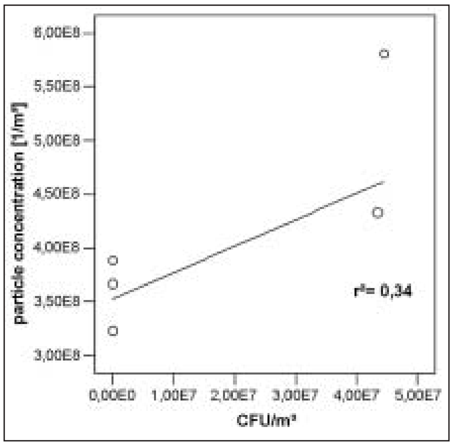

Fig. 5: Relationship between PM 5 and the mould spores collected with the FSP in the dust releasing cube

Test methods

The measuring instruments were installed in a 22 m^2 box stall. The instruments were protected by a grid cage installed on an unused feeding trough at a height of 1.20 m (*Fig. 1*). The measurements were carried out over a period of eight hours, beginning at 7.30 a.m. before feeding. Preliminary analyses of the continuous data from the long-term measurements provided hints about the diurnal development of the particle load in the barn air. Based on these analyses, point measurements were carried out over periods of two hours at times of high as well as of low activity and dust levels respectively. The aim of these point measurements was to determine for two extreme situations, with particle concentrations that would be as homogeneous as possible, whether there was a correlation between dust particles and moulds. A “dust releasing box“ (*Fig. 1*) developed at the Institute for Agricultural Engineering was used to simulate, as a standardised method and under constant external conditions, one of the activities in horse barns connected with the highest dust emissions, namely roughage feeding. Once again, the aim was to establish homogeneous particle concentrations and to subject them to a correlation analysis. Another focal question was in which way the relation between dust particles and mould spores would change, if the germ content of the sample changed. The simulation instrument is a wooden cuboid with side lengths of 62 cm and 52 cm which is suspended to rotate around its vertical axis. By means of an electric motor the cuboid can be rotated at a speed of 9 rpm. The material samples used in these tests were two batches of hay, one of which was of high quality, whereas the other was very mouldy. 100 g of each of the samples were placed in the middle of the “dust releasing box“ and rotated for one minute. Immediately afterwards, the sampler heads of the measuring instruments were inserted into the openings on the sides of the box to measure the released particles over a period of 15 minutes. An Ahlborn climatic console was used to monitor the temperature and relative humidity during the measurements.

Results

The results of the regression analysis of the data acquired in the long-term measurements in the horse barn are presented in *Table 1*. It contains only size ranges with a coefficient of determination of $r^2>0.6$. A high coefficient of determination was calculated for the total dust concentrations and the mould spores detected with the GSP sampler head during the point measurements (*Fig. 3*). The correlation between the fine-particle ranges and the small mould spores was weak. A similar observation was made with regard to the data acquired with the “dust releasing box“.

In this case, too, the total particles and the mould spores measured with the GSP sampler head had the highest coefficient of determination (*Fig. 4*). Further regression analyses, which are not listed here, with different dust size classes (1.0-5.0 µm) and the moulds measured with the GSP sampling head had coefficients of determination, ranging from r^2=0.7 to r^2=0.9.

Table 1: Results of the regression analysis of mould-spiked particles from level 1 and 6 and selective size ranges of dust particles in a horse barn

Level 5 of the AS	0.30-0.40 µm	1.6-2.0 µm	Level 6 of the AS	1.6-2.0 µm	Level 7 of the AS	1.6-2.0 µm
Regression equation	y=0.001x +76463.187	y=0.105x +87809.870	Regression equation	y=0.26x +(-12882.169)	Regression equation	y=0.00033x +46.363
Coefficient of detemination	0.654	0.649	Coefficient of detemination	0.647	Coefficient of detemination	0.730

Conclusion

A rough estimate of the mould content of the air on the basis of concentration developments of airborne particles is only possible for total dust concentrations. The coefficient of determination between the fraction of fine particles, which can penetrate to the deeper regions of the lungs, and mould spores of the same size is low. A significant positive correlation (r^2= 0.9) was primarily found between the total dust content and the mould content measured with the ”dust releasing box“, using the GSP sampling head. This result is due to the homogeneity of the released amount of dust and mould. In conclusion, it is possible to assess mould loads by measuring particle number concentrations using the “dust releasing box“.