Jens Seedorf, Hannover

Emissions of airborne dust and micro-organisms

Emissions of dust and micro-organisms increasingly play a role in the environmental-hygienic risk estimation of existing and planned livestock buidings. This report describes building interior air concentrations and emission values of inhalable and alveolus-admittable dust as well as airborne bacteria and fungi. The report shows that the highest particle concentration and emission per animal unit (GVE) is to be found in poultry production in comparison with cattle and pig housing. Thus, for instance, the emission rate of inhalable dust equalled 3165 mg/h and GVE, a figure which exceeded the emissions from cattle housing by a factor of 22 and that from pig housing by a factor of four.

Dr. med. vet. Jens Seedorf is scientific assistant at the Institute for Animal Hygiene and Animal Protection of the Hanover Veterinary High School, Bünteweg 17p, 30559 Hanover; e-mail: jseedorf@bakum.tiho-hannover.de

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Keywords

Dust, microorganisms, emissions

Alongside the emissions of gases and odours, the release of particle forms from livestock buildings is increasingly becoming the focus of public interest. Thus, it is feared that emissions of dust and micro-organisms from livestock housing could similarly threaten health amongst neighbouring populations as they already have been proved to do via work-related disease, as described many times in the past, amongst livestock personnel [1].

With this as background, results over livestock housing particle concentrations, and the associated emission rates, are presented here.

Airborne germs and dust in livestock housing

Composition and effects

Particle-form air components in livestock buildings belong to the complex of composite dusts. Contrary to many industrial dusts, it is possible to differentiate between living and dead components with livestock housing dust. That the dust is mainly comprised of organic substances is indicated by the crude protein content of up to 50% of total mass [2].

Onto the distributed dust particles in the housing air are adsorbed micro-organisms. These include bacteria, viruses, fungi and yeast. These microcosms can, further, be settled by single cell animals (protozoa) and store mites.

The largest proportion of the germs in the air are of the species Staphylococci and Streptococci, which comprise up to around 80% of the total germ flora in the housing air. These bacteria originate mainly from the animal body surface and the faeces. Alongside these gram positive bacteria also exist gram negative bacteria (representing a proportion of up to 0.5%) such as, for example, Escherichia coli, a faecal germ. Fungi represented in the livestock housing air make up approximately 2% of the microflora there [3], whereby this total is dependant on the quality of the litter.

Confronting the mainly apathogenic nature of the micro-organisms regularly in evidence in the air culture of animal housing are various infectious organisms which can also carry out their infective biological potential through the air passages. Representatives of such infectious agents are, for example, Pasteurella, foot and mouth viruses or also Aspergillum fungi. Brought together in *table 1* are the already known and potentially health-endangering dust components and the diseases associated with them.

Dust components	Diseases
- Feed components (Grain, antibiotics, growth promoters) -Animal protein (urine, epithelia, serum) - Faecal matter, (intestinal flora, intestinal epithelia, feed components) - Fungi - Pollen - Grain mites, Insect remains - Mineral dust - Gram-negative bacteria - Endotoxins - β-1,3-glucan-histamine - Microbial protozoa - Particle linked NH_3 - Infection germs	- Mucous membrane irritation - Allergic rhinitis - Exogenic allergic alveolitis (EEA) - Organic dust toxic syndrome (ODTS) - Bronchial hyperreagibility - Work associated asthma - Chronic obstructive pulmonal diseases

Table 1: Potentially harmful dust components [4] and associated diseases

Contents of livestock housing air

The amount of dust to be contended with in animal housing depends on many factors. The origin and the elimination of aerogenic particles depend on the feeding (dry – liquid), housing system (with or without litter), livestock activity, type of animal (hair – feathers), faecal technology (manure cellar, air-drying on manure belt) or also on the degree of interior air movement. Despite this, it is possible to determine basic graduated differences between the livestock types cattle, pigs, and poultry, such as those revealed in a completed EU research project. Measured on the basis of inhalable dust (total dust) there was in cattle production (cows, feeding bulls, calves) systems around 0.38/m^3 on average, in pig housing (sows, weaners, feeding pigs) 2.19 mg/m^3 and with layers and broilers average concentrations of 3.60 mg/m^3. Alongside such inhalable dust particles, especially the alveolus-admittable dust fractions are of importance in a health context, in that the dimensions of the particles with a diameter of <5 µm are capable

of reaching the lung alveoli where gas exchange takes place. In analogy to the inhalable dust figures, the lowest average concentrations of alveolus-admittable dust is met with in cattle housing, followed by pig and poultry housing. The respective aerogenic contents are 0.07, 0.23 and 0.45 mg/m^3 [5].

Micro-organisms carried in the livestock housing air mostly do not appear in isolated form but associate on dust particles in so-called clusters which can indicate strongly variable germ loadings. Here, the aerogenic microbial concentrations also vary within wide limits. Additionally, the preparation technique based on collection and laboratory work also influences the germ figures to a not inconsiderable extent. In this case, a cultural evidence system is usually used which takes the micro-organisms still capable of reproduction after sample collection and lets them multiply as colonies on a culture. Should the germ total resulting from this be given in decadal logarithms, it would be possible to determine mesophilic total bacteria concentrations which during the day in cattle buildings would lie by around 4.4 log KBE (Colony Building Unit) per m^3 air, and in pig buildings by 5.2 log KBE/m^3. Not only, with an average of 5.8 log KBE/m^3, does poultry housing air show the greatest aerogenic loading of total bacteria, it also claims the highest position as far as the air content of mesophilic fungi is concerned with 4.1 log KBE/m^3 in comparison to cattle and pig housing with 3.8 log KBE/m^3 in each case [6].

Emission rates of dust and germs

The particle-form components are released into the environment in the livestock building exhaust air. The emission rate can be calculated here as the product from building air concentration and airflow which can, for instance, be estimated over a carbon dioxide-material flow balance. If the emission rates are based on animal units (GVE = 500 kg liveweight) from these are produced calculated emission rates for dust [5] and micro-organisms [6] in *table 2* and *fig. 1*.

Proportionately, cattle housing emitted less inhalable and alveolus-admittable dust than poultry housing by factor of 22 and 21. Based in pig housing, the factorial difference lay by 4 and 6. With the germ-based emission rates of poultry, especially the broilers were prominent with a total bacteria count emitted of around 3368 mio. KBE/h and GVE and with fungi around 55 mio. KBE/h and GVE [6]. With this, the germ-specific emission rate lies at around 213 times or 53 times higher than for layer housing, a situation certainly caused also by the standard of the housing type. The dust-releasing potential of the litter in the case of broiler production stands alongside the litter-free battery cage housing system with aerated manure belt for laying hens.

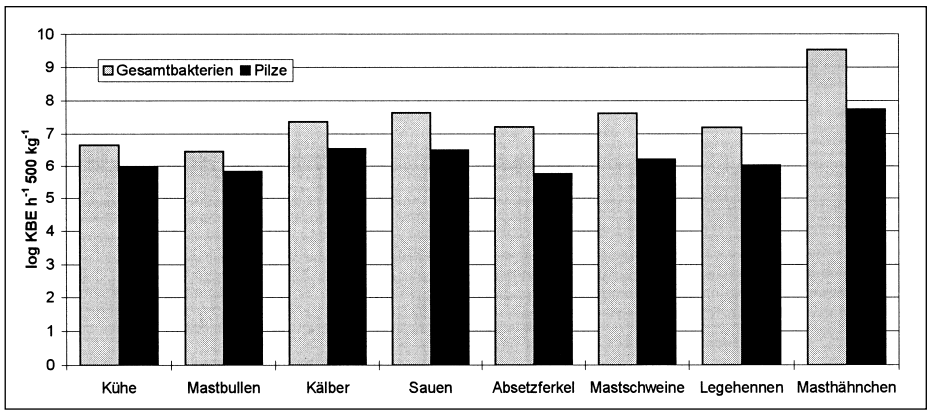

Fig. 1: Emission rates of total bacteria and fungi (n = 61)

Conclusion

Particle-form air pollution in livestock housing leads, to a not insubstantial extent, to health dangers for people and animals in the building. Through the ventilation systems, the dusts, the dust components and micro-organisms are emitted into the environment. Here, graduated differences in the emission rates between cattle, pig and poultry housing can be observed, whereby the latter demonstrates the greatest emission potential for inhalable and alveolus-admittable dust as also for culture-viable bacteria and fungi. However, such a general statement should not be made without always bearing in mind that factors such as litter, degree of animal activity or also the feeding technology could be involved to a not inconsiderable extent in the amount of emissions. Therefore, production system variants should be checked for "environmentally friendly relevancy" as well as for aspects of animal protection.

A solid environmental-hygienic risk estimation alone through the knowledge of emission rates is hard to imagine as long as immission measurements on a broad basis in the surrounding areas of livestock farms are missing. Therefore it is urgently advised to carry out such measurements around livestock farms and to introduce a biological evaluation for the immission concentrations thus determined.

	Cattle		Pigs		Hens	
	Inh. dust	Alv. dust	Inh. dust	Alv. dust	Inh. dust	Alv. dust
mg/h GVE	145	24	762	85	3165	504

Table 2: Dust emission rates from livestock (n = 329)

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