ESTIMATION OF A „SAFE DISTANCE“ BETWEEN A NATURAL VENTILATED BROILER HOUSE AND A RESIDENTIAL DWELLING

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Introduction:

The air of animal houses contains bioaerosols such as bacteria [1], fungi [2], allergic compounds [3] and endotoxins [4] which can affect the health of farmers and farm animals. In recent years there is increasing concern of residents living close to livestock buildings, that they may also be affected by these aerosols which are emitted and distributed by way of the exhaust air from these barns.

This paper reports on a case study investigating the emission of bioaerosols from a natural ventilated broiler barn and their immission in front of a nearby dwelling unit which is surrounded by other buildings and trees.

Material and methods

In order to asses the bioaerosols at a residential dwelling unit the following installations and procedures were used: (1) Installation of a weather station to measure the local wind speed and wind direction during the measuring campaign. (2) Detection of micro-organisms, indicator bacteria and endotoxins in the ambient air upwind the barn, downwind the barn and at a dwelling. (3) Defining sampling points relative to the centre of the barn, and calculating the deviation from the main wind direction. (4) Assessment of the immissions at the residential dwelling by direct measurements and by comparison with similar experiences gathered by measurements in open field situations.

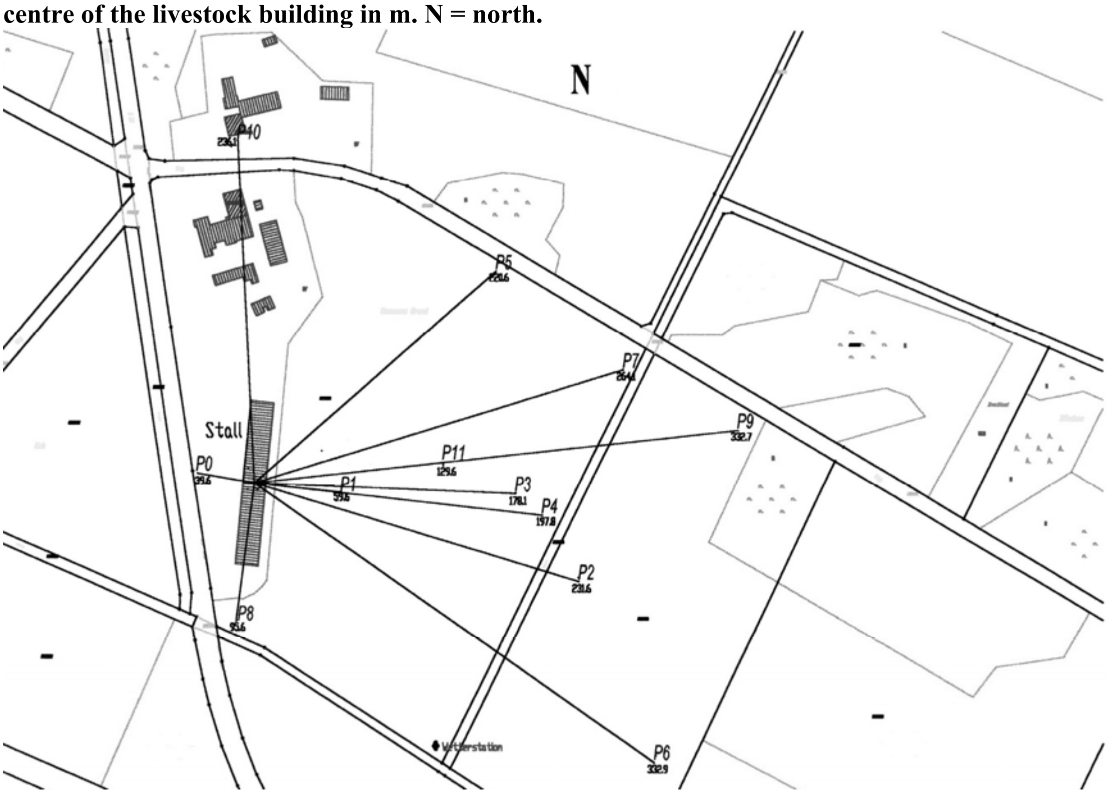
The local wind speed and wind direction was measured, by a UNIKLIMA 7 weather station (TOSS, Potsdam) 220 m south-east of the barn, as given in Figure 1. Micro-organisms were sampled with special AGI-30 impingers fixed on weather masts in heights of 1.5m, 4.0m, and 9.5m. With these impingers it is possible to detect bacteria concentrations of less than 100 cfu/m^3. Indicator bacteria (staphylococci) were identified from these samples as described by Schulz et al. [5]. Aliquots were taken from the impingers to count airborne fungi. The liquids were plated on dichloran-glycerol-agar (OXOID LTD, Basingstoke, Hampshire, England) and incubated for five days at 25 C. Endotoxins (ET) were extracted from the inhalable dust samples which were collected with IOM samplers (SKC, USA) and Universal-Deluxe pumps (Analyt-MTC, Mühlheim) in the same heights as the micro-organisms and analysed with the LAL-test (KQCL-Test, Fa. Biowhittaker, USA).

The distances and the angles of the measurement points were determined with a TC 110 Tachymeter (Leica Geosystems, Switzerland). The positions were visualized in an electronic map of the investigated area with the AutoCAD programme.

Results

Figure 1 presents the sampling points (P) relative to the centre of the investigated livestock building calculated with an AutoCAD programme.

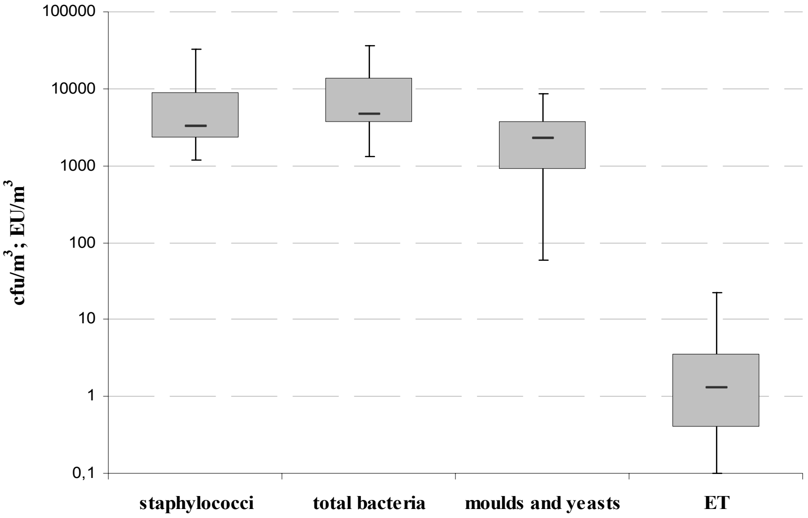
Fig. 1: Sampling points (P), the position of the weather station (Wetterstation) and the residential dwelling (P10) in the surrounding of a broiler house (Stall). Numbers below P describe the distances to the centre of the livestock building in m. N = north.



30 impinger samples (ten in each height) from P11 (n=6), P5 (n=6), P7 (n=6) and P9 (n=12) were taken in main wind direction (±10°) on the downwind side of the barn when high emission rates of bioaerosols were expected (summer, appropriate wind speed, broilers older than three weeks). Figure 2 summarises the results of measurements at sampling points in open field situation between 130 and 330 m down wind the broiler barn on micro-organisms (colony forming units (cfu)) and ET (8ng ~ 1EU) per m^3. The median for the total bacteria count which also includes staphylococci came to 4611 cfu/m^3, staphylococci reached a median of 3304 cfu/m^3. The ET concentrations were with about 2 EU/m^3 rather low. No

bacteria were found on the upwind side of the barn in the impinger samples which were taken in parallel at the same time (detection limit 100 cfu/m^3).

Fig. 2: Boxplots of bioaerosol concentrations measured in distances between 130m and 330m on the downwind side of the broiler barn.



The concentrations of moulds and yeast were in general lower than bacteria concentrations. However, the number of moulds and yeasts were probably influenced by emissions that were not originating from the broiler barn because some measurements revealed that the concentrations of moulds and yeasts were higher on the upwind side than on the downwind side of the barn. The ET concentrations were obviously influenced by emissions of the barn because upwind concentrations were always lower. Some of the ET results varied extremely between different heights (differences more than 90%) whereas bacteria concentrations were always in the same range.

Measurements were carried out at the residential dwelling (P10, distance 236m to the barn) when barn and building were directly in the main wind direction and when the broilers were close to the end of the growing cycle. We had only two situations in four months which met these conditions. The measurements of total bacteria, moulds, yeasts and ET in front of the building revealed no clear differences from the upwind concentrations. An analysis of the hourly average wind direction from the local weather station (May to September 2003) showed that this house was only 1.7 % of the total hours of the measuring campaign (4 months) in the main wind direction. When taking the data files of the last 4 years provided by “Deutscher Wetterdienst” less than 3% of the hourly average wind directions during a year were in the direction of the residential dwelling.

Discussion

The results show that there is a considerable emission potential of broiler houses for micro-organisms and ET, in the last weeks of the fattening period in particular. When measuring total bacteria, fungi and ET in the surrounding of broiler barns there is the risk that other sources [6] than the broiler barn can contribute to the results and may lead to biased conclusions. Therefore, these bioaerosol components are less suitable for quantitative studies of this type. An ideal indicator component should be typical for the source, not present in the ambient air and easy to detect. It seems that staphylococci may meet these criteria. At sampling point P10 no staphylococci were found in spite of an ideal wind direction directly coming from the broiler barn. Probably the presence of some old farm buildings and high oak trees (see Fig.1) between the broiler barn and the dwelling influenced the spread of the bioaerosols. It is well known that trees and building structures can decisively hamper the distribution of airborne particles.

Conclusions

Bioaerosol emissions from broiler barns can pose a thread to nearby residents. For the assessment of a health hazard it is important to estimate the amount of pollutants which may reach the subjected dwelling. Total bacteria counts, fungi and ET do not seem to be appropriate indicators for a typical pollution because they can originate from other sources than, as in this case, the broiler barn. Staphylococci seem to be much more suitable as indicators for bacterial immissions because they do not normally appear in the outside air. However, when trying to estimate "safe distances" by measuring the distribution of micro-organisms in the ambient air of barns it is not only important to consider the meteorological conditions such as wind direction and wind speed but also the topographical structures including houses and trees which can significantly influence the spread of bioaerosols. This has obviously happened in the presented case study.

Acknowledgements

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