Project brief

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How long do bacteria survive in the air?

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- **Large quantities of bacteria are released into the environment from animal houses via exhaust air.**
- **It is not known how long the bacteria survive in the air and are potentially infectious.**
- **To answer this question, we have developed a novel bioaerosol chamber.**
- **On warm summer days, up to 99.9 % of the bacteria die after 12 minutes, in winter they do not.**

It is not known how long bacteria survive in the exhaust air of livestock facilities and are thus potentially infectious. We have investigated this in the TeluMi project (Tenacity of Airborne Microorganisms).

Background and aims

The air in animal housing facilities contains large amounts of bacteria that enter the environment via exhaust air and can potentially affect human and animal health. Specific to animal facilities is the staphylococcus group of bacteria. Computer models are used to model the spread of staphylococci from animal facilities and to calculate the concentrations in the environment. For realistic modelling, it is also necessary to take into account how long staphylococci survive in the air.

The survival of bacteria in the air depends on temperature, humidity, solar radiation and the so-called "open air factor" (OAF). The OAF describes a germicidal effect on microorganisms that only occurs in fresh outdoor air. The ozone concentration plays a major role in this.

In order to determine the survival rates of bacteria in the air, we have developed a new type of test chamber in which experiments can be carried out under real outdoor air conditions. In it, we have investigated how long different staphylococci survive in the air under different climatic conditions. These data should help to improve the computer models.

Procedure

The special thing about our test chamber is that it consists of a folded foil balloon. This is continuously inflated outdoors with fresh outside air. In the process, the volume of air inside doubles every two and a half minutes (Figure 1).

In the different seasons, the survival rate of staphylococci in the outdoor chamber was examined under different weather conditions. In each case, the ratio between all bacterial cells and only the living bacterial cells was determined after they had been in the chamber air for 12 minutes. In addition, the respective temperature, relative humidity, global radiation and ozone concentration were measured.

Figure 1: Novel test chamber, fully inflated

Results

It was possible to create meteorological conditions in the chamber that are representative of our latitudes. The experiments were carried out at temperatures between - 3 °C in winter and 35 °C in summer and at relative humidities between 20 % and 80 %. The global radiation varied greatly over the course of the year between 4.81 W/m² on a dull winter morning and 978 W/m² in summer with full sunlight. The ozone concentration was a maximum of 0.315 ppm. At high temperatures, high ozone concentrations and low relative humidities, few bacteria survived in the air. However, the influence of global radiation was most obvious

Figure 2 shows the survival rates in % of bacteria of the species *Staphylococcus xylosus* as a function of global radiation. The bacteria were present as individual cells in the air. The values fluctuated strongly in the range of two powers of ten. Nevertheless, an exponential decrease in the survival rate can be seen with increasing radiation intensity. Above 500 W/m², only 10 % of the bacteria were still alive after 12 minutes.

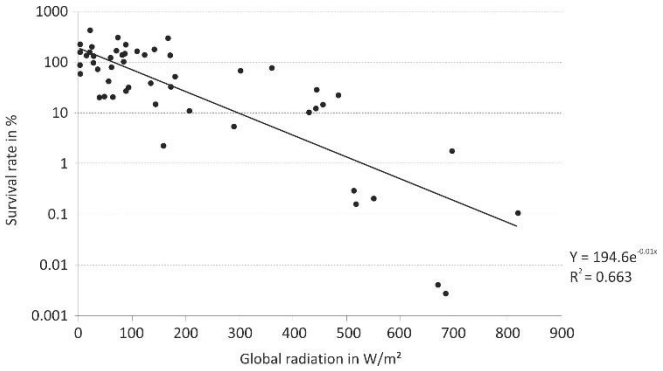

Figure 2: Survival rates of *Staphylococcus xylosus* after 12 minutes in the airborne state as a function of global radiation (n = 54)

In further experiments, fresh chicken house dust was blown into the chamber and it was investigated how long the staphylococci contained therein survive. Figure 3 shows the dependence of the survival rate on global radiation. Here, too, the survival rate tends to decrease with increasing radiation intensity. A reduction in the survival rate of over 90 % was found in isolated cases with global radiation values > 200 W/m². However, the range of variation is significantly higher than in the previous experiments with *S. xylosus*, and an exponential drop in the survival rate is not so clearly recognisable.

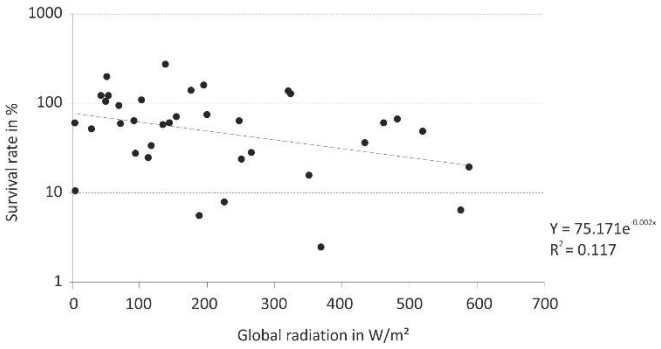

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Figure 3: Survival rates of staphylococci in chicken house dust after 12 minutes in the airborne state as a function of global radiation (n = 32).

In contrast to the previous experiments, the bacteria here were not in the air as individual cells, but on and in the dust particles. The results indicate that the dust protects the bacteria from the global radiation to some extent. After 12 minutes in the airborne state, many fewer died compared to the single cells of S. xylosus. For this reason, the experiment was repeated twice in the summer in a larger chamber and the bacteria were kept in the air for twice as long for about 25 minutes. The global radiation was on average approx. 500 W/m², the temperature 35 °C, the relative humidity 30 % and the ozone concentration 0.025 ppm. Figure 4 showed a clear exponential decrease in the survival rates of airborne staphylococci in stable dust over time with little variation. After 10 minutes, only 90 % survived. After 25 minutes, survival rates of less than 0.1 % were found. Thus, a strong reduction in the survival rates of airborne staphylococci due to the weather is to be expected, especially on sunny, warm days.

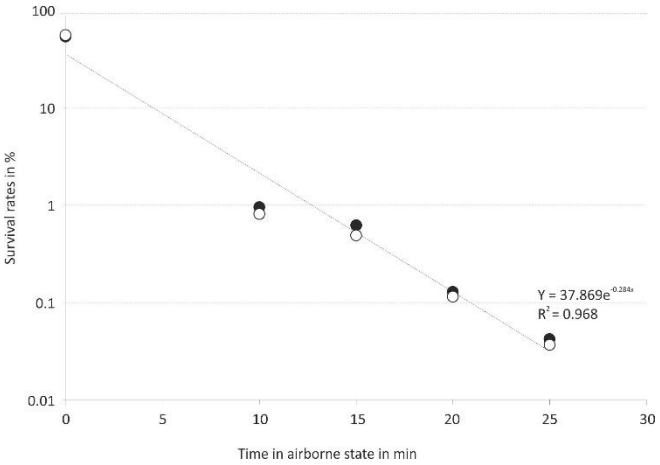

Figure 4: Survival rates of airborne staphylococci in chicken house dust as a function of time (n = 2)

Conclusions

In our novel test chamber, the survival rates of airborne bacteria can be determined under outdoor air conditions. Temperature, relative humidity, ozone and global radiation have an influence on the survival rate of staphylococci in the air. Global radiation has the greatest effect. If the bacteria are present individually in the air, less than 0.1 % survive after 12 minutes on warm, sunny days. If the bacteria are bound to dust particles and thus protected, it takes up to 25 minutes. In winter or at night, bacteria survive significantly longer.

Our data are suitable for improving dispersion models. The prerequisite for this is that corresponding values for e.g. global radiation are also available. Furthermore, it should be examined whether survival rates for temperature or even for combinations of values are also useful. A pragmatic approach would also be conceivable, since according to current findings the influence of implementing a survival rate will not have a major impact on the calculation of annual mean immission values in the vicinity of livestock facilities, especially in temperate latitudes. However, the situation would be different when calculating time series or when the long-distance transport of microorganisms is to be considered.

Weitere Informationen

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