

# Bioaerosol

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## Abstract

Bioaerosols are defined as a collection of aerosolized biological particles which can vary greatly in size, ranging from less than 20 nm to 100 microns in diameter. The composition, size, and concentration of the microbial populations comprising the bioaerosol vary with the source, dispersal mechanism in the air, and, most importantly the environmental conditions prevailing at a particular site. The ultimate effect of bioaerosols on human and animal health will depend on the organism characteristics, growth conditions, and organism viability. Air will often contain micro-organisms such as viruses, bacteria, and fungi. None of these actually live in the air, the atmosphere tends to kill off most of them. However they are frequently transported attached to other particles, such as skin flakes, soil, dust, or dried residues from water droplets. Airborne fungal cells (yeasts, moulds, spores) can remain viable for much longer periods, even at low relative humidity and high or low temperature extremes. Animal farms, farming of land, application of manure, wastewater/sewage treatment and composting belong among significant sources of bioaerosols.

The aim of the present study was to investigate survival of selected groups of bacteria in animal houses with different animal species using two different methods. Their spreading in the outer environment was also monitored as an important way of transfer of aerogenic diseases.

## Introduction

Bioaerosols originating from potentially pathogenic sources may have the potential to cause disease in humans and animals if transported on air currents. Additionally, if the environment into which microorganisms are aerosolised promotes the growth and survival of bioaerosols, higher concentrations may occur and pose a risk to health.

Temperature can both increase and decrease bacterial bioaerosol concentrations. Increasing temperature has been found to decrease the survival of bacterial bioaerosols under experimental conditions (Handley and Webster 1995), and in a greenhouse (Marthi *et al* 1990). In the natural environment, bacterial bioaerosol concentrations have been positively related to temperature (Tong and Lighthart 2000).

Relative humidity is often associated with bacterial bioaerosol survival as well. Increases in relative humidity are known to increase survival (Marthi *et al* 1990) especially under the influence of direct sunlight (Handley and Webster 1995). Under foggy conditions (100% humidity) bacterial bioaerosols are thought to propagate in the air (Fuzzi *et al* 1997), supporting the assumption that a higher humidity increases survival. In an outdoor agricultural setting, relative humidity was found to be negatively correlated with bacterial bioaerosol concentrations (Tong and Lighthart 2000).

While environmental conditions can play a big role in bioaerosol investigations, the characteristics of the bioaerosol source are also important to consider. While bacteria are ubiquitous in most environments (with the exception of “clean” places where efforts are made to remove as much bacteria as possible), simply detecting bacteria is of little consequence. However, downwind from sources that are thought to contain potentially pathogenic organisms, the detection of organisms could signify a problematic situation.

The aim of the present study was to investigate survival of selected groups of bacteria in animal houses with different animal species using two different methods, simple sedimentation and MAS-100 ECO method. Spreading of bacteria to the outer environment was also monitored as an important way of transfer of aerogenic diseases.

## Material and methods

Samples of air inside and outside animal clinic facilities were taken and evaluated by two methods. We focused on total plate counts (meat-peptone agar, incubation at 37°C for 24 h), plate counts of total coliforms (Endo agar, incubation at 37°C for 24 h) and on moulds (Sabouraud agar, incubation at 22°C for 5 days).

### Sedimentation method

It is an apparatus-free method. The aerosol is allowed to settle on uncovered Petri dishes in which an appropriate culture medium has been placed. The exposure time is set according to the presumed bacterial air contamination from 1 to 10 minutes. However, recalculation per 5 minutes exposure is always necessary. The number of bacteria present in 10 liters of air corresponds to the number of bacteria which sediment onto an area of 100 cm<sup>2</sup> in five minutes. After exposure, the culture medium is incubated according to the type of micro-organisms to be examined. After the incubation, the colonies are counted. The number of microorganisms sedimented from 1 m<sup>3</sup> of the air is found according to the formula:

$$\text{Number of gerbs in 1m}^3 \text{ of air} = 636 * \frac{a*t}{r^2}$$

Where: a - number of colonies; t - time recalculated per 5 minute sedimentation;  
r<sup>2</sup> - radius of the Petri dish in cm

### MAS-100 ECO method

The MAS-100 Eco air monitoring system is a compact sampler for use with standard Petri dishes. It is possible to select from the following aspiration volume ranges: 1, 2, 5,10, 20, 50 and 100 litres of air. Petri dishes with respective nutrient media are placed on top of the dish support of the sampler and after aspiration of preset volume of air, they are incubated at appropriate temperatures. The plate counts obtained for both methods were recalculated per 1 m<sup>3</sup> of air.



## Results

Tab 1. Results of sedimentation method

	Total count		Total coliforms		Moulds	
	CFU/m <sup>3</sup>	Exposure time(min)	CFU/m <sup>3</sup>	Exposure time(min)	CFU/m <sup>3</sup>	Exposure time(min)
Cows	1526	5	0	5	636	5
	3688	1	0	1	1526	1
Pigs	NC	5	51	5	102	5
	419	1	0	1	127	1
Horses	3307	5	0	5	7632	5
	8650	1	0	1	26712	1

NC – noncountable

Tab. 2 Results of MAS-100 ECO method

	Total count		Total coliforms		Moulds	
	CFU/m <sup>3</sup>	Litres sampled	CFU/m <sup>3</sup>	Litres sampled	CFU/m <sup>3</sup>	Litres sampled
Cows	19,2x10 <sup>3</sup>	5	0	5	5,2x10 <sup>3</sup>	5
	42x10 <sup>3</sup>	2	0	2	8x10 <sup>3</sup>	2
Pigs	NC	5	51	5	6,2x10 <sup>3</sup>	5
	NC	2	0	2	9,5x10 <sup>3</sup>	2
Horses	46,4x10 <sup>3</sup>	5	0,8x10 <sup>3</sup>	5	33,2x10 <sup>3</sup>	5
	102x10 <sup>3</sup>	2	1x10 <sup>3</sup>	2	61x10 <sup>3</sup>	2
Poultry	NC	5	3,2x10 <sup>3</sup>	5	NC	5
	NC	2	4x10 <sup>3</sup>	2	9x10 <sup>3</sup>	2

NC - noncountable

## Discussion

Air is an important medium for transfer of many diseases. Micro-organisms present in the air of animal houses may affect negatively the health, growth and productivity of animals (Ondrašovič et al., 1997).

Airborne microbes in animal houses arise from the livestock, their litter and their feedstuffs. More than 80% of the airborne microorganisms found with cattle, pig and poultry are staphylococci and streptococci. They originate mainly from the skin and from the upper respiratory tract. Fungi, moulds and yeasts can form more than 1% and coli-type bacteria about 0,5% of the total aerial count (low viability in the air).

The nature of the airborne microflora acts as a "mirror" of the microbiological status of the animal house.

Bacteria levels are influenced by - the density of stocking, age of animals, the ventilation system, the microclimate, the level of dust in the air and deposited on surfaces.

The number of microorganisms present in the air in animal houses varies. In most cases it is in the range between 10<sup>3</sup> and 10<sup>6</sup> (10<sup>8</sup>), germs in one cubic metre of air.

The recommended maximum acceptable concentration of microorganisms in the animal houses is 250 000 in 1m<sup>3</sup>.

Total coliforms have been used for the measurement of bioaerosols in different environments where there could be possible faecal contamination (Brandi et al 2000, Stampi et al 2000, Adams and Spendlove 1970). Fungi are investigated because they are often linked with bioaerosol diseases, such as hypersensitivity pneumonitis, farmer's lung (Stanford 1990), SBS (Harrison et al. 1992), allergy problems, i.e. aspergillosis (Awad and Farag 1999) and others (Seltzer 1994). Incidences of bioaerosols causing disease in an agricultural setting are common.

The results of many monitorings give a very wide range of germ concentrations. This could be explained by the fact that different techniques for bacteria sampling have been used.

Results of our investigations showed that higher numbers of bacteria were detected when using the MAS-100 ECO method, and the results were more consistent. This is

logical as the instrument ensures exposure of Petri dish to micro-organisms from preset volume of air. It also showed that with the exception of horses, coliform, especially E.coli, do not survive long in the air. The recommended value was exceeded for moulds with horses which is not unusual with regard to use of considerable quantity of bedding, The only disadvantage of the MAS-100 ECO method was that the smallest air sample with this instrument was 1 l which can result in uncountable number of colonies on exposed plates.

In conclusion we should stress that the method used affects considerably the plate counts which should be considered when interpreting the results.

#### **Literature references**

- Adams, A.P., Spendlove, J.C.: (1970) Coliform aerosols emitted by sewage treatment plants. *Science*. 169: 1218-1220
- Awad, A.H.A., Farag, S.A.: (1999) An indoor bio-contaminants air quality. *International Journal of Environmental Health Research*. 9: 3 13-3 19
- Brandi, G., Sisti, M., Amagliani, G.: (2000) Evaluation of the environmental impact of microbial aerosols generated by wastewater treatment plants utilising different aeration systems. *Journal of Applied Microbiology*. 88: 845-852
- Fuzzi, S., Mandrioli, P., Perfetto, A.: (1997) Fog droplets - an atmospheric source of secondary biological aerosol particles. *Atmospheric Environment* 31(2):287-290
- Handley, B.A., Webster, A.J.F.: (1995) Some factors affecting the airborne survival of bacteria outdoors. *Journal of Applied bacteriology*. 79: 368-378
- Harrison, J., Pickering, C.A.C., Faragher, E.B., Austwick, P.K.C., Little, S.A., Lawton, L.: (1992) An investigation of the relationship between microbial and particulate indoor air pollution and the sick building syndrome. *Respiratory Medicine*. 86: 225-235
- Marthi, B., Fieland, V.P., Walter, M., Seidler, R.J.: (1990) Survival of bacteria during aerosolisation. *Applied and Environmental Microbiology*. 56(8): 1286-1289
- Ondrašovič, M., Ondrašovičová, O., Vargová, M., Kočíšová, A.: (1997) Environmental problems in veterinary practice, University of veterinary medicine, Košice, 19-20
- Stampi, S., Zannetti, F., Crestani, A., DeLuca, G.: (2000) Occurance and seasonal variation of airborne gram negative bacteria in a sewage treatment plant. *Microbiologica*. 23:97-104
- Stanford, C.F., Hall, G., Chivers, A., Martin, B., Nicholls, D.P., Evans, J.: (1990) Farmer's lung in Northern Ireland. *British Journal of Industrial Medicine*. 43: 314-316
- Tong, Y., Lighthart, B.: (1999) Diurnal distribution of total and culturable atmospheric bacteria at a rural site. *Aerosol Science and Technology*. 30: 246-254