



Comparative study of airborne culturable microorganisms at selected sites in waste management, keeping of domestic animals and in the neighbourhood

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1. Summary

In the last few years, air germ measurements in the field of waste management and at reference sites were made in one-month intervals by means of six-step Andersen Cascade Impactors and the mean values of colony forming units of mesophile bacteriae, mould fungi, thermophile bacteria and of *A. fumigatus* were determined.

Within the present study, additional investigations were made into stables with mass keeping of animals. Except for the number of germs of mesophile bacteriae in the stables, the emission values in stables for domestic animals were significantly lower than in the waste treatment facilities. The immission values in the immediate surroundings of the waste treatment facilities were above the values at the reference sites, the background level being achieved from a distance of 150-300m. In the immediate surroundings of stables for domestic animals, the immission values were similar to the background values.



2. Starting Position

The investigations of the last few years have shown that the highest mean values for culturable mould fungi ($1,4 \times 10^5$ KBE/m³), *Aspergillus fumigatus* ($1,7 \times 10^4$ KBE/m³) and mesophile bacteriae ($1,1 \times 10^5$ KBE/m³) occurred in closed sorting cabins while thermophile bacteriae (actinomyces, incl. bacillaceae; $7,3 \times 10^3$ KBE/m³) were evidenced much more at technical large-scale composting facilities than at the other sites. Furthermore, differences between the individual composting systems (open and closed facilities) could be acquired. In the present study, first results of comparative investigations of composting facilities and stables for domestic animals with mass keeping of animals are presented. Furthermore, the numbers of germs on so-called "unloaded measuring places" (background values) are stated and serve as a basis for assessing immissions relating to facilities.



3. Procedure

The following facilities were investigated into:

- **Composting Facility 1**
 - Input material: 25% bio-waste, 25% shrub clippings, 50% sewage sludge. Type of facility: closed intensive rotting with separate boxes made of armoured concrete.
Capacity: appr. 8000 t/year, 75t rotting material/rotting box

- **Composting Facility 2**
 - Input material: 75% bio-waste, 25% shrub clippings.
 - Type of facility: Open intensive rotting on a roofed paved surface
 - Capacity: appr. 1200 t/year, 45t rotting material/rotting box
- **Stables for Domestic Animals**
 - Pigs' fattening facility: 3 stables with 200 animals each.
 - Batteries for laying hens: Stable with 60,000 animals.

The reference sites selected were four measuring places in rural and municipal vicinity in the Greater Graz area, at which effects of waste treatment facilities or stables for domestic animals could be excluded. At each facility, measurements were, (for one year), done on a monthly basis (between 10 am and 2 pm (only at good weather conditions)) directly on the sources of emission at a distance of 50 and 100 m from the facilities. The measuring instrument used was the six-step Andersen©1ACFM Cascade Impactor (suction height: 1.8m above the ground). The measuring time amounted to 1 minute on the immission points and to 15 seconds on the emission points. The statistical evaluation of the specimens [calculation of the mean, minimum and maximum values as well as making the box plots] was done by means of SPSS (Release 8.0.0).

Nutrient Media	Incubation	Germinal Spectrum
Tryptic-Soja-Agar (TSA1) , additive: 1ml cycloheximide (50µg/ml) MERCK 5458; Glucose-Yeast Extract-Malt Extract-Agar (GYM) with 5% NaCl ; Standard I-Malt Extract-Agar (StIM); Czapek-Dox-Yeast Extract-Casamino Acid-Agar (CYC) with 200µg/ml Novobiocin	50°C	thermophile actinomycetes + thermophile bacillae
Tryptic-Soja-Agar (TSA2) , additive: 2ml cycloheximide (50µg/ml) MERCK 5458	37°C	Bacteriae
Blood Agar Basis, additive: 5-10% sterile human blood OXOID CM271	37°C	Aspergillus fumigatus
Malt Extract-Agar (MEA) + additive: 3ml streptomycine (0.2g/l) + penicilline (0.1g/l) MERCK 5398	25°C	Mould fungi

Table 1 Nutrient Media for Vaccination and Differentiation



4. Results/Benefits

The mean values of the numbers of germs at the reference sites were between 0 (residential area) and 18×10^1 (rural area) for thermophile actinomycetes, between 5 (pasture) and 1×10^1 for *A. fumigatus* and between 3×10^1 and 1.3×10^2 (rural area) for thermophile bacillae, between 1.2×10^2 and 1.8×10^2 for bacteriae and between 4.7×10^2 and 1.2×10^3 KBE/m³ for mould fungi (Table 2).

Microorganisms	Rural Area		Municipal Area		Background value***
	Near agriculture	Pasture	Road with much traffic	Residential area	
Bacteria (TSA2, 37°C)	150	150	180	120	120 - 300
Mould fungi (MEA, 25°C)	500	1200	880	470	500 - 1500
Thermophile actinomycetes (TSA1, 50°C)	18	9	4	0	0 - 20
Thermophile bacillae (TSA1, 50°C)	130	40	30	30	0 - 150
Aspergillus					

fumigatus (Blood agar, 37°C)	10	5	10	10	0 - 10
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Table 2 Background values on so-called "unloaded" measuring places
(mean values in KBE/m³) *** recommended reference values (mean values) for the natural background load by considering the applied measuring technique

The results confirm the investigations made up to now, which helped to demonstrate that there may be high emissions of airborne culturable microorganisms in the area of composting facilities. It was also at the direct comparison between stables for domestic animals and composting facilities that measurements relating to the facilities showed the highest mean values of bacillae, thermophile actinomycetes, mould fungi and *A.fumigatus* in the composting facilities in the immediate vicinity of main rotting. In the course of composting, high numbers of thermo-tolerant and thermophile microorganisms are caused by the microbial succession depending on temperature. This explains the high numbers of germs for thermophile bacillae and thermophile actinomycetes as well as for *A. fumigatus*, which also gets good growth conditions in the course of composting and is prevalent in the ambient air at waste treatment .

In **comparison to the airborne germs in the surroundings of the facilities**, it became obvious that the numbers of germs in the area of the stables for domestic animals, which were stated for all the types of germs investigated into, were not higher than the background values while the number of these microorganisms in the surroundings of composting facilities exceeded the background values within the measuring range of 150m. Previous studies, however, helped to show that these background values in a range between 150m and 300m were reached depending on the climatic and geographical conditions. It is true that germs may also be transported over larger distances depending on the wind conditions. Nevertheless, this is only shown in single measurements and is not decisive for the overall load . As for a possible impact exerted on the neighbourhood, the distances principally specified for composting facilities in Austria amount to 300m (hospitals and others: 1000m). According to the local climatic and geographical conditions and a corresponding expertise, it is possible to provide for a distance that is below this distance. Relating to the protection of the neighbourhood, the annoyance caused by bad smell, which is due to the operation of composting facilities and stables for domestic animals, has to be attached more importance to than the impact exerted by germs. As for the emission of mould fungi, it became obvious in the course of the projects that natural sources of emission could highly influence the values so that this group of germs is a parameter that is only suitable for assessing the emission of a facility to a limited extent [3].

As for **assessing the risk potential** due to germ emissions from waste treatment facilities, it is recommended to quantitatively and qualitatively evidence the main sources of exogenous-allergic alveolitis (EAA), *Saccharopolyspora* sp., *Saccharomonospora* sp, *Streptomyces albus*, *Thermoactinomyces* sp. and *Aspergillus fumigatus* and to refrain from the acquisition of the number of germs for mesophile bacteriae and mould fungi. This is due to the fact that no relation between the dose and the effect can be established for the likelihood of falling ill and the overall number of germs.

As for **assessing immissions**, the values of the natural presence of airborne microorganisms, which have been determined in the present study, may be used as a basis for comparison (Table 2). The prerequisite is the use of the same measuring and cultivating techniques.

