

Bioaerosols and Composting

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Definition of Bioaerosols

- Micro-organisms and/or other small biological particles suspended in the air.
- Bacteria, fungi, cell wall components of bacteria and fungi
- Fine dust is also included

Bioaerosols

- The EPA considers bioaerosol emissions as one of the potential negative impacts of composting facilities.
- Some waste licences for compost sites have included bioaerosol monitoring

Objective of 'Bioaerosol and Composting' Document

1. Provide a comprehensive reference document based on international literature.
2. Assessment on public health risks associated with bioaerosols.
3. Recommendation on health risks associated with bioaerosols.

Bioaerosols and Composting

- Composting is a microbiological process.
- During turning biological agents are aerosolised.

Responses to Bioaerosols

- Responses to bioaerosols are host and dose dependent.
- Aspergillosis is the condition caused by *Aspergillus fumigatus* - rare in healthy individuals.
- Major publicity regarding *Aspergillus fumigatus* and St. Anne's Park
- Responses can range from mild cases of inflammation, allergy to serious infection by secondary pathogens.

Aspergillus fumigatus

- Levels found in composting facilities in other countries ranged from 10^2 - 10^3 CFU/m³.
- Some allergic symptoms were noted at one site, these were associated with levels of ozone, ragweed and temperature.
- Levels recorded in other industries:
 - 10^3 CFU/m³ - poultry house
 - 10^2 CFU/m³ - mushroom house
 - 10^2 - 10^4 CFU/m³ - timber processing

Total Fungi

- Levels found in composting facilities in other countries ranged from 10^2 - 10^5 CFU/m³.
- Site activity, seasons and distance from source affected the levels recorded.
- Levels recorded in other industries:
 - 10^3 - 10^9 CFU/m³ - harvesting and storage of grain
 - 10^4 - 10^8 CFU/m³ - sawmill

Endotoxin

- Levels found in composting facilities in other countries ranged from 0.32 ng/m³ - 640 ng/m³.
- Good correlation between respirable dust levels and endotoxin levels.
- Dutch Expert Committee on Occupational Standards of the National Health Council suggest **4.5 ng/ m³** over an 8 hour exposure period.
- Rylander suggested that up to **100 ng/m³** should be considered safe until additional information is available.
- Levels recorded in other industries:
 - 62-1950 ng/m³ - Fur animal bedding
 - 6-779 ng/m³ - Glasshouse
 - 50-100 ng/m³ - Livestock Industry

Total Bacteria

- Levels found in composting facilities in other countries ranged from 10^2 - 10^5 CFU/m³.
- Biofilters and distance from activity decreased concentrations considerably.
- Levels recorded in other industries:
 - 10^2 - 10^6 CFU/m³ - Water Treatment (Activated Sludge)
 - 10^3 - 10^5 CFU/m³ - Animal Facilities
 - 10^2 - 10^3 CFU/m³ - Harvesting and Storage of grain

Dust

- Small solid particles, $< 75 \mu\text{m}$ in diameter
- PM_{10} : 50% efficiency at $10 \mu\text{m}$ in aerodynamic diameter (respirable)
- Levels found in composting facilities in other countries ranged from $0.1 \text{ mg}/\text{m}^3$ - $12 \text{ mg}/\text{m}^3$.
- Information on other industries was not available.
- PM_{10} levels of $34\text{-}50 \mu\text{m}/\text{m}^3$ is acceptable to the U.S. EPA.
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Conclusions on Concentration Data

- Indicative rather than absolute: due to different type, location and various measuring system
- Levels found similar to other industries
- Workers get higher exposure, more in an indoor facility than outdoor

Buffer Distances

-where measured levels reach background levels

- Can vary from 61m to 2614m (sewage sludge composting).
- In most cases <200m-300m bioaerosol levels reach background levels.
- Recommended buffer zone of 200m, especially for e.g. greenwaste
- Distance should be flexible depending on trees, prevailing wind direction, bunds, type of material being composted

Buffer Distances

-where measured levels reach background levels

- Recommend a buffer distance 300m from dwelling site, depending on trees, bunds or biofilter.
- 500m where bioaerosol levels would be particularly high
- U.K EPA suggest if set back distance is less than 250m, background measurement particularly for *Aspergillus fumigatus* should be conducted

Bioaerosol Sampling

- Why sample? Bioaerosol monitoring only if definite requirement (U.K Composting Association, Oregon Department of Environmental Quality)
- What to sample for. (*Aspergillus Fumigatus*)
- When and where to sample. (Over a year)
- Cost.
- Sampling methods. (Anderson Sampler)

Bioaerosols and Health Risks

- General population not at risk. 'Composting facility does not pose any unique endangerment to the health and welfare of the general public'.
- Immune-compromised individuals are at increased risk.
- Asthmatic and other 'allergic' individuals are at increased risk.
- Occupational exposure to bioaerosol may be significant

Bioaerosols and Health Risks

- No occupational exposure standards for bioaerosols either in U.K. or elsewhere in Europe.
- Dose and effect response for dust, micro-organisms, endotoxin for plant workers has not been determined

Addressing Bioaerosols at Irish Composting Facilities

- Baseline Research
- Bioaerosol control plan should consist of
 - Facility Siting and design
 - Site operation

Addressing Bioaerosols at Irish Composting Facilities

- Facility siting and design
- Site Operation
 - Operational Controls
 - Engineering Controls
 - Protection Equipment
 - Worker Hygiene
 - Medical Consideration
 - Sampling

Additional information from a Workshop (London)

- A Seminar was organised by the Sustainable Organic Resource Partnership entitled: 'Bioaerosol from Organic Wastes: What's the Problem?'

Bioaerosol from Organic Wastes: What's the Problem? Dr. Toni Gladding, Open University

- Papers presented were:
- 1: Introduction and review of health effects including disease and allergic responses to bioaerosols and other particulate emissions by Dr. Toni Gladding, Open University
 - Dose/response relationship
 - Short term vs. long term effects
 - Risks to different individuals
 - Reliability of measurements Techniques etc

Bioaerosol from Organic Wastes: What's the Problem? Dr. Benjamin Tanner University of Arizona USA

- 2: Assessment of microbial Risks Associated with the land application of bioaerosols by: Dr. Benjamin Tanner University of Arizona USA
 - Overall risk of infection from bioaerosol resulting from land application (of sewage sludge) is low
 - Occupational risk greater than community risk but still low
 - Community risk insignificant

Bioaerosol from Organic Wastes: What's the Problem?

Dr Brian Crooke, Head
of Microbiology, Health and Safety Laboratory

- 3: Assessment of risks of airborne pathogens (bioaerosol) from composting operators. Dr Brian Crooke, Head of Microbiology, Health and Safety Laboratory
 - Potential Risk of Exposure
 - Workers closely associated with site activity
 - Workers intermittently associated with site activity
 - Workers in premises
 - Members of public living in the vicinity of composting sites
 - Members of the public passing by the periphery of site

Bioaerosol from Organic Wastes: What's the Problem?

Dr Brian Crooke, Head
of Microbiology, Health and Safety Laboratory

- Bioaerosol and Windborne dispersion
 - 90-150 m
 - Some cases up to 500m
- Reported ill health associated with compost bioaerosols
 - *Aspergillus fumigatus* is a major concern
 - Only 2 published case reports of such
 - Infection closely associated with compost bioaerosol

Bioaerosol from Organic Wastes:

What's the Problem?

Dr Brian Crooke, Head of Microbiology, Health and Safety Laboratory

- Comparison with other Industries
 - 10^6 – 10^8 Hay or grain
 - 10^6 – 10^8 Pigs and poultry
 - 10^5 – 10^6 Textile, metal working
- Tools for risk Assessment
 - Exposure Measurement
 - Mathematical Dispersion model

Bioaerosol from Organic Wastes: What's the Problem?

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■ Future Needs

- 250 m boundary, 249 good, 252 bad?
- Better to have risk zones with different levels of protection/mitigation
- Present studies have been using snapshot measurements, better to have long term continuous measurement methods

Conclusion

- Health risks to workers and general public are minimal-can be managed if certain procedures are followed.
- Research on bioaerosols should be conducted to develop baseline values in Ireland. (especially for *Aspergillus fumigatus*)
- Annoyance studies can yield useful information.
- Bioaerosol Control plan should be developed.

For each specific composting facility (including facility siting / design, site operating parameters).

- Development of educational material

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