

Fact Sheet BIOAEROSOLS IN WASTE MANAGEMENT

An aerosol consists of particles small enough to be suspended in the air and remain airborne. These particles are generally between 0.01 μm (1/1000 mm) to 100 μm in diameter. There is particulate material in every breath taken and in healthy people the respiratory system (Figure 1) is very efficient in removing this. Aerosolised particles of less than 5 μm in diameter behave very similarly to bulk air and can be deeply inhaled.

Bioaerosols are defined as airborne material containing biological material from animals, plants, insects or micro-organisms. They are produced wherever biological material is being processed, milled, or chopped and should be regarded as ubiquitous. Examples of work sites where significant bioaerosols are produced include oxidation ponds at wastewater treatment plants, composting facilities, harvesting agricultural crops, and log processing at timber mills.

There are two different classes of biological material that contribute to the makeup of bioaerosols that can pose a potential health risk to susceptible persons; those that contain viable micro-organisms (such as bacteria, viruses, fungi or fungal spores) that can potentially cause infections; and those that contain non-viable material (for example, animal dander, pollen, or endotoxins) that act as allergens.

Generally bioaerosols are made up of a combination of these classes of material. Since it is not pragmatic to eliminate bioaerosol production in the composting process, steps need to be put in place to sensibly manage any adverse risk that can arise.

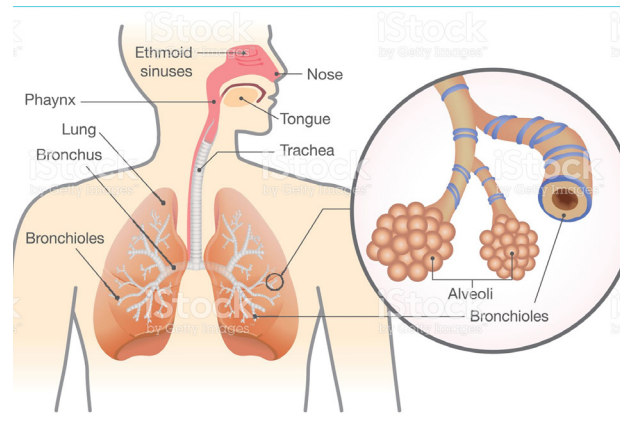


Figure 1 – Human Respiratory System

The main risk of exposure is to workers involved in the operational aspects of processing compost. Members of the public who live or are otherwise in close proximity to outdoor composting plants where there are no systems in place to capture contaminants as they are released, may also be exposed.

WHAT DOES THE LAW SAY?

The Health and Safety at Work Act 2015 (HSWA) and supporting regulatory framework requires that Persons Conducting a Business or Undertaking (PCBU) must identify hazards that could give rise to reasonably foreseeable risks to health and safety and manage these risks including those associated with substances hazardous to health.

NOTE: *The New Zealand Workplace Exposure Standards (WES) DO NOT specify an exposure limit for bioaerosols that is acceptable to human health.*

Assessing the effects of risks to worker health is a mandatory requirement for all PCBUs who must determine, through risk assessment, the exposure likelihood and consequences from identified health hazards. Where these hazards exist that give rise to potential health risks and the PCBU is unsure of the concentration level in the workplace, then Exposure Monitoring must be undertaken.

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As a result of the Exposure Monitoring outcomes, Health Monitoring of workers may also be required to be undertaken. This must be conducted in compliance with the process described in the *Health and Safety at Work (General Risk and Workplace Management) Regulations 2016*.

WorkSafe NZ describes Work Related Health as having two distinct components, which are interrelated. These are shown in Figures 2 and 2A and describe the Effects of Work on Health and the Effects of Health on Work.

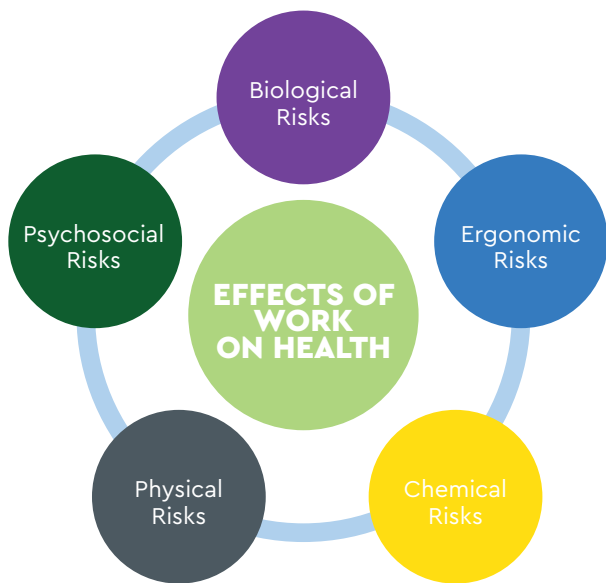


Figure 2 – Work Related Health – Effects of Work on Health



Figure 2a – Work Related Health – Effects of Health on Work

RISK ASSESSMENT

Figure 3 shows that for an adverse effect to occur following exposure to a bioaerosol, three interdependent events need to align:

1. There has to be a contaminated source where the biological agent is produced and multiplying (Biological reservoir);
2. There has to be a means for a person to come into contact with the source; the prerequisite being the biological agent in an aerosolised state (Bioaerosol generation);
3. The person has to be susceptible to the disease caused by the biological agent (Susceptible person).

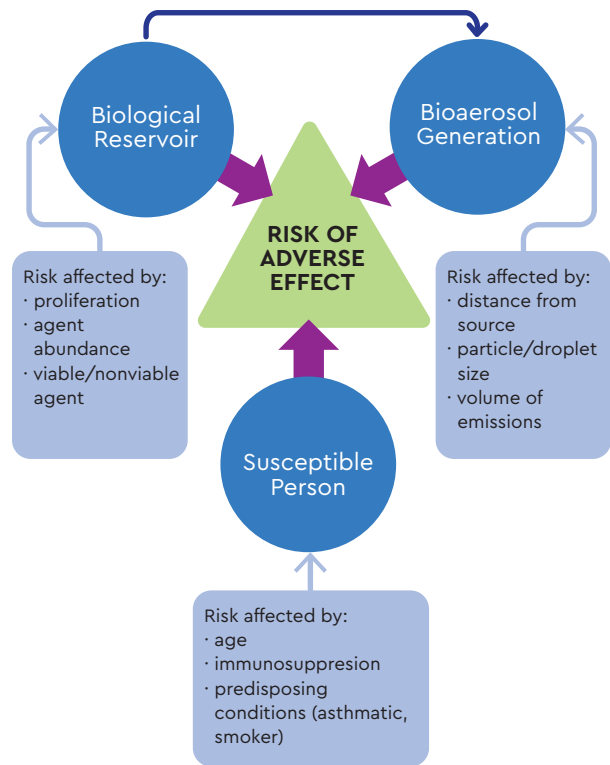


Figure 3 – Factors that affect bioaerosol risk

The biological reservoir

Wherever there is organic material there will be micro-organisms present. The composting process is dynamic and influenced by many different microbiological and environmental factors, but the principal action is carried out by the micro-organisms present in the organic material. The microbial population, growth, and activity are primarily affected by the make-up of the compost feedstock, moisture levels, heat and pH. The levels of different pathogenic micro-organisms, if present, will not be static during the composting process.

Enteric pathogens such as *salmonella* are likely to be present in high numbers at the beginning of the composting process when food, animal or sewage waste are part of the feedstock, and usually decrease during the composting process.

Legionella bacteria are likely to be low at the start of the process, but will be present in higher numbers during the maturation process where temperatures are more likely to suit its growth and the growth of its hosts. *Aspergillus* fungi are another potential pathogen and allergen and can be found in compost at any stage in significant numbers.

At no stage can it be assumed that the compost material is completely pathogen-free, so steps to reduce pathogen load or exposure to any aerosols generated need to be followed.

Bioaerosol generation

The potential for aerosols to be produced from the composting process can occur at the following stages:

- initial shredding of the organic-waste
- filling and emptying of vessels and vehicles
- formation of windrows or static piles
- the physical turning of the material in the windrow or static pile during the maturation stage
- the screening and bagging of the mature compost

Once generated, the bioaerosol can remain suspended for considerable time, from minutes to hours. The amount of bioaerosol in the air reduces the further the distance from the activity due to particle settling and the dilution affect from bulk air movement. Prevailing weather and wind conditions will affect the dispersement and spread of any bioaerosol.

The susceptible person

Aerosolised particles of less than 5 µm in diameter behave very similarly to bulk air and can be deeply inhaled. A susceptible person is one who has little resistance against a particular organism and who, if exposed to this organism, is likely to become sick. People who have a respiratory illness are more susceptible than those that don't.

Particle deposition patterns are different in healthy lungs compared to diseased lungs due to changes in lung physiology. These differences may play a role in the factors predisposing the immunocompromised and those with underlying lung issues to infections from airborne pathogens suspended in bioaerosols.

Pathogen concentration and composition of the bioaerosols and the length of time and frequency that an individual is exposed to the bioaerosol influence the outcome of an exposure event.

METHODS OF CONTROL

Minimise

- The mechanisms for controlling dust are often very effective at controlling bioaerosols e.g. water control, misting and vegetation on boundaries.
- Mobile plant used to process compost should be fitted with air filtration systems.
- When working in outdoor environments where bioaerosols may be created, wind direction should be considered.
- Buffer zones between processing facilities and urban or populated areas should be in place.
- When working at indoor composting facilities, work should be done in a well-ventilated area, ensuring that building design has considered the required air changes per hour based on the activities in the building.

Administrative

- Comprehensive pre-employment health checks should be undertaken to identify any pre-existing conditions which could be affected from exposure to bioaerosols.
- An ongoing health monitoring regime should be conducted regularly throughout a worker's period of employment.
- Organisational Risk Assessments, Standard Operating Procedures, worker training and emergency response measures are in place and known by those working with or in the vicinity of compost windrows.
- Exposure monitoring of worksites where bioaerosols are likely to be a risk should be carried out using generally accepted microbiological methods.

Personal protective equipment

- Appropriate Respiratory Protective Equipment (RPE) should be used by workers who could be exposed to bioaerosols. Ref AS/NZS 1715:2009 *Selection, use and maintenance of respiratory protective equipment*.
- PCBUs should ensure that appropriate Fit Testing is undertaken for workers using Respiratory Protective Equipment.

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- Workers should use appropriate eye protection.

Note: All the above controls should be in place whether the composting activities are indoors or outdoors.

LABORATORIES

PCBUs should undertake appropriate due diligence in identifying a suitable laboratory to collect and/or assess environmental samples. Any laboratory selected for assessing samples should be accredited to IANZ and ISO 17025 *General requirements for the competence of testing and calibration laboratories*.

Reference Material

- Defra Project WR 1121 *Bioaerosols and odour emissions from composting facilities*, August 2013
- Health and Safety at Work Act 2015
- Health and Safety at Work (General Risk and Workplace Management) Regulations 2016
- Kampen Vera van; et al, Concentration of Bioaerosols in Composting Plants Using Different Quantification Methods, *Ann Occup. Hyg.* 2014, Vol. 58, No. 6, 693–706
- Nathalie Wery, *Bioaerosols from Composting Facilities*, *Frontiers in Infection and Cellular Microbiology*, 4 April 2014
- The UK Association of Organics Recycling, *Health and Safety Composting Sites*, Chapter 4
- WasteMINZ *Health and Safety Guidelines: for the Solid Waste and Resource Recovery Sector parts one, two, three, four and five*
- WorkSafe NZ, *Healthy Work; Strategic Plan for Work Related Health 2016–2026*

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