

Microbial update

Airborne micro-organisms

Produced as a service to the food industry by Oxoid Ltd.

Micro-organisms occur in the air as aerosols, which can be defined as a suspension of solid or liquid particles in air or gas. Microbiological aerosols include bacteria, yeasts, moulds or viruses which occur either singly or in clumps and may be free floating or be attached to a dust particle. They are generated whenever the surface film of a liquid is broken, and may remain suspended in the air for long periods of time.

Aerosols may be generated by numerous means including shakers, blenders, running water and air-conditioning units and show complex aerodynamic behaviour resulting from physical influences such as Brownian motion, electrical gradient, thermal gradients, humidity and gravitational fields.

How aerosols are generated and how they behave has an important influence on the survival of airborne micro-organisms.

Biological stresses occur during the generation and deposition of an aerosol as well as while the particle remains airborne. These factors are especially relevant when combined with other stresses such as dehydration, irradiation and oxidation.

It is important that these stresses are taken into account when air sampling is carried out, as stressed organisms may be unable to tolerate certain selective agents.

Air sampling methods

Due to the low levels of contaminating micro-organisms held within aerosols it means that relatively large volumes of air have to be monitored when attempting to sample the environment. The exact sample volume depends on the system used and the estimated contamination in that environment.

The methods of collection available to sample these environments fall into two general categories:



● Passive monitoring (sedimentation).

Settle plates are the most common method of passive air monitoring.

● **Active monitoring.** This includes impaction onto solid surfaces (for example agar plates), impingement in liquids and filtration onto a solid surface which is then placed in a liquid or solid medium.

Within a 'clean environment', for example operating theatres and food and pharmaceutical clean rooms, impaction methods are generally chosen. Within a highly contaminated environment, impingement or filter methods may be more appropriate.

Sedimentation

When airborne contamination was first perceived to be a food safety issue, sampling was generally carried out using settle plates. Agar plates were placed in areas around the plant or production area and exposed to the atmosphere for a set period of time.

Airborne micro-organisms settle onto the agar and the plate is then incubated under appropriate conditions. The number of colonies that develop are noted.

The resulting count does not produce a measure of the number of micro-organisms in a given volume of air, but shows the number of micro-organisms being deposited onto a known area in a known time.

A disadvantage is that air turbulence around the plate may affect settling and very small particles might not settle on the plate at all. However, changes in counts may be used as an indication of a change in the microbial quality of the air.

Impaction

Impactors draw air into the device and then cause it to change direction forcing it to pass over a standard agar plate or other collecting device. Particles present in the air then fall onto the agar. The plate is incubated at an appropriate temperature and observed for microbial growth. One disadvantage of this type of sampler is that smaller particles may not impact onto the agar surface and some of the particles may deposit onto surfaces other than that of the growth medium.

● Slit to agar samplers.

Air is pulled through a narrow slit, so that the particles within it are deposited onto a rotating agar plate, spreading the particles over the plate surface. A large plate (150 x 15mm) is used for the rotating turntable, which may be a disadvantage if comparisons with other methods using standard Petri dishes are desired. The drying action of the vacuum and plate rotation may cause the agar to dry out, leading to further osmotic stresses on already stressed micro-organisms. They are also less efficient when collecting small particles, as these may be deposited in the sampler itself rather than on the agar plate, or they may remain in the air stream and be discharged to the atmosphere.

● Sieve sampler.

This type of sampler usually has a series of sieves with progressively smaller holes from the top of the device to the bottom, an agar plate is placed between each sieve. Air is drawn into the sampler at a relatively low speed so only the largest particles impact on

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the agar plate. The air then travels around this first agar plate and through the second sieve to impact on the second agar plate. As this process continues down through the stack of plates, the air is drawn through increasingly smaller holes leading to an increase in the air speed. This greater momentum leads to even very small particles impacting onto the agar plates. Other devices simply have one sieve head with a number of small holes through which air is drawn in at a fixed flow rate for a variable time. Some sieve impaction devices allow the use of standard Petri dishes, which means that there is a greater flexibility when selecting a suitable growth medium.

● **Centrifugal sampler.**

This utilises a rotary fan to draw air in and onto the agar growth medium. The centrifugal force means that particles are impacted onto the agar at a rate which is related to their size. These devices may overestimate the total count, as a flow rate selected on the median particle size can preferentially select for larger particles.

Impingement

This type of air sampler draws air in through a tube and deposits it into a suitable liquid medium. The liquid must be carefully chosen to optimise the capture of all particles and the tube and sampling time must be monitored carefully to minimise evaporation.

Filtration

Air is sampled at the desired flow rate and is drawn through a gelatine membrane which traps particles from the air. The membrane is very efficient and is capable of trapping particles as small as viruses within it. As the filter is made of gelatine, its water content helps to protect stressed cells. After sampling, the membrane is placed into liquid culture medium or onto an agar plate. The

membrane then dissolves ensuring that all micro-organisms are released into the growth medium.

When deciding on a suitable air sampling method, it is important to consider the benefits and problems associated with each of the methods in order to determine which most closely meets the requirements.

Airborne pathogens

Most pathogens are sensitive to the hostile environment of the air, but some are either adapted to this mode of transmission or are sufficiently robust to survive, even if airborne transmission is not the usual route of infection.

● **Legionnaires' disease.**

The first recognised outbreak of Legionnaires' disease occurred in 1976 at an American Legion convention in Philadelphia when 221 people became ill and 34 died of a then unknown illness. The symptoms were 'flu-like' initially, leading to pneumonia characterised by shortness of breath and chest pain. When the causative bacterium was isolated, it was named *Legionella pneumophila*. This is a true airborne pathogen, as it only causes disease if it is inhaled, with transmission through droplets generated from environmental sources or from devices that generate aerosols.

● **E. coli O157.**

E. coli O157 infection is usually self-limiting however the illness may progress to a severe colitis with bloody diarrhoea, and severe abdominal pain. About 5% of these cases develop Haemolytic Uraemic Syndrome (HUS) which is a form of acute kidney failure.

Most commonly associated with contaminated food, there is some evidence that this organism may, under the right circumstances, be an airborne pathogen. In a case in the US, 23 people became ill after visiting a multipurpose building which was displaying farm animals during a show. Six people were hospitalised and two of these went on to

develop HUS.

Subsequent investigations failed to find any link with food or drink on sale at the event. Environmental sampling revealed that the organism was present in dust on the building's rafters. It is thought that the micro-organisms became airborne when sawdust used for animal bedding was disturbed by the visitors, leading to the creation of aerosols.

● **Fungal spores.**

Fungal spores are very commonly found in the air, as this is the most common mode of dispersal for fungi and other non-flowering plants. Fungal spores found in indoor environments include *penicillium*, *alternaria*, *eurotium*, *cladosporium*, *aspergillus* and *wallemia*. The *zygomycetes* are one of the smallest groups of fungi, but many species are important as spoilage organisms in foods. As well as being a food spoilage concern, some species of fungi produce spores that are allergenic, causing allergic responses in susceptible individuals.

Air monitoring

Air sampling, within the context of the food industry, can be defined as the collection and analysis of airborne microbiological contaminants that may impact on food safety or spoilage.

Many food manufacturers are beginning to see the benefit in pro-actively monitoring one of the largest 'surfaces' in their food production facility. With the increasing reliance on hazard analysis within the food industry, the requirement to monitor the quality of the air surrounding the manufacturing environment is becoming ever more important and in some cases required as part of a HACCP plan. ■

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