New insight about bioaerosol exposure in Waste Sorting Plants: Exposure levels, size distribution, and biodiversity of airborne microorganisms

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Bioaerosol emitted by working activities in Waste Sorting Plants (WSP) were associated with several health disorders such as rhinitis, asthma and hypersensitivity pneumonitis. Previous studies carried out in WSP provided data about airborne dust, endotoxins, (1,3)-β-D glucans as well as culturable bacteria and fungi. So far, the size distribution of bioaerosols in WSP has not been investigated. Futhermore, the microbial biodiversity data published from WSP underestimate the real microbial taxon richness as they were obtained by cultivation of microorganisms on nutrient media prior to identification. However, both size distribution and biodiversity would supplement exposure measurements and provide a better understanding of biological risks encountered in this occupational environment. The aim of the study was to investigate the exposure to airborne dust, endotoxins, culturable bacteria and fungi as well as size distribution and biodiversity of bioaerosols in a WSP.

Stationary and individual samples were collected in a WSP located in France. Inhalable endotoxins, bacteria and fungi were sampled using a 37 mm closed-face cassette (CFC) at 2L/min and inhalable dust was sampled using the CIP 10-I at 10 L/min (Duquenne et al., 2012; Simon and Duquenne, 2014). The size distribution of airborne dust and culturable fungi and bacteria was investigated using the Marple Cascade Impactor (Mylar disks, 2 L/min). For biodiversity investigations, bioaerosols were sampled using a CFC (10 L/min) and submitted to 18S rDNA and 16S rDNA high-throughput sequencing after DNA extraction (FastDNA®SPIN kit for soil, MP Biomedicals, USA). The bioinformatic analysis of sequences was performed using the Mothur software. Bioaerosol samples were collected for five hours in relevant working area of the WSP, for main working tasks and on 4 different working days. Outdoor samples were also collected as references.

Exposure to inhalable endotoxins and dust were between 4.7 and 212.6 EU/m^3 and below 3 mg/m^3, respectively (except 52.5 mg/m^3 for one worker involved in maintenance). Exposure to inhalable culturable fungi was from 8.6 x 10^3 to 1.5 x 10^6 CFU/m^3 and varied as a function of the sampling day, the working area and tasks. They were the highest for one worker involved in maintenance. Exposures to culturable bacteria varied in a similar trend but with generally lower levels.

The gravimetric investigations revealed a polydispersed size distribution (δ_g = 2.5) with d_{ae} of airborne particles from 1 to 40 µm. A similar size distribution was observed for airborne particles carrying bacteria. On the contrary, the size distribution of airborne culturable fungi (Figure 1) revealed a uni-modal population (median d_{ae} ~ 3.0 µm and δg = 2.5).

Bioaerosols found in the different working area were dominated by bacteria belonging to the phyla *Firmicutes* (11 families), *Actinobacteria* (11 families), *Bacteroidetes* (9 famillies), and *Proteobacteria* (24 famillies). Frequently found genera were *uncultured Comamonadaceae*, *Limnobacter*, *Flavobacterium*, and the hgcI clade of Actinobacteria. The relative abundance of taxa varied with the sampling date and the working area but no tendencies could be deduced from the data. Data from outdoor samples and from biodiversity of airborne fungi will be described during the presentation.

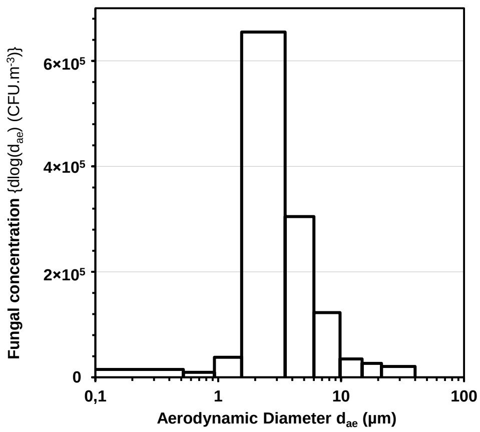

Figure 1. Size distribution of airborne fungi in a cabin sorting cardboards.

The study corroborates previous findings about workers exposure to endotoxins, bacteria and fungi in WSP. It provides new data dealing the size distribution as well as biodiversity of bioaerosols in this occupational environment. These results encourage further investigations of spatial and temporal variation in size distribution and in biodiversity of bioaerosols found in WSP.

Duquenne et al., (2012). *J. Environ Monit,* **14**: 409-419.
Simon X. and P. Duquenne (2014). *Annals Occup. Hygiene,* **58**: 677-692.