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Airborne bioaerosols and their impact on human health

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ABSTRACT

Bioaerosols consist of aerosols originated biologically such as metabolites, toxins, or fragments of microorganisms that are present ubiquitously in the environment. International interests in bioaerosols have increased rapidly to broaden the pool of knowledge on their identification, quantification, distribution, and health impacts (*e.g.*, infectious and respiratory diseases, allergies, and cancer). However, risk assessment of bioaerosols based on conventional culture methods has been hampered further by several factors such as: (1) the complexity of microorganisms or derivatives to be investigated; (2) the purpose, techniques, and locations of sampling; and (3) the lack of valid quantitative criteria (*e.g.*, exposure standards and dose/effect relationships). Although exposure to some microbes is considered to be beneficial for health, more research is needed to properly assess their potential health hazards including inter-individual susceptibility, interactions with non-biological agents, and many proven/unproven health effects (*e.g.*, atopy and atopic diseases).

Contents

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Introduction

Bioaerosols are very small airborne particles (ranging from 0.001 to 100 μm) that originate biologically from plants/animals and can contain living organisms (Georgakopoulos et al., 2009). Therefore, pathogenic and/or non-pathogenic dead or alive microorganisms (*e.g.*, viruses, bacteria, and fungi) may exist in bioaerosols (Mandal and Brandl, 2011). Bioaerosols are easily shifted from one environment to another because of their small size and light weight (Van Leuken et al., 2016). In recent years, exposure to bioaerosols in both occupational and residential environments has drawn much attention in light of their probable impacts on human health.

Sources of bioaerosol exposure in occupational activities are diverse enough to include waste sorting and composting, agricultural and food processing activities, the livestock industry, *etc.* (Pearson et al., 2015). Indeed, the prevalence of diverse respiratory diseases or symptoms (allergic asthma, rhinitis, airway inflammation, *etc.*) has been reported from workers susceptible to such exposure (Beck et al., 2012; Rohr et al., 2015). Bioaerosols were estimated to be responsible for approximately 5 to 34% of indoor particulate matter air pollution (Mandal and Brandl, 2011). The sources of indoor bioaerosol pollution include outdoor sources (passing through windows, doors, and ventilation); building materials; furnishings; occupants; pets; house plants; and organic wastes (Nazaroff, 2016). Regular or ordinary human activities (*e.g.*, coughing, washing, toilet flushing, talking, walking, sneezing, and sweeping floors) are also capable of generating bioaerosols (Chen and Hildemann, 2009). However, basic environmental conditions, such as temperature and moisture content, can considerably influence the extent of their formation and dispersion due to their controlling effect on the formation of microorganisms (Dedesko et al., 2015). Consequently, the prevalence of bioaerosols can be associated with certain human diseases, such as pneumonia, influenza, measles, asthma, allergies, and gastrointestinal illness (Srikanth et al., 2008). However, under certain circumstances, exposure to some microbes is beneficial for health in terms of developing a healthy immune system and protect children from developing allergies and asthma (Severson et al., 2010). Although the importance of bioaerosols and their impact on human health has been recognized, it is yet difficult to accurately describe their role in the initiation or worsening of diverse symptoms and diseases. Table 1 presents the types of microorganisms and their resulting diseases. In this review, we give a comprehensive overview on bioaerosols based on the most recent publications covering this subject, with major emphasis on their compositions, and health effects. As a result, we hope that this review work will help researchers extend and establish better knowledge in relevant fields.

Table 1 – Microorganisms and some of the major resulting diseases.

Order	Species	Approximate size	Resulting disease	Infection/transmission
1	*Legionella pneumophila*	Length: 2 μm Width: 0.3–0.9 μm	Legionnaires' disease	Inhalation of a water aerosol containing the bacteria
2	*Mycobacterium tuberculosis*	Length: 2–4 μm Width: 0.2–0.5 um	Tuberculosis	Person to person through the air
3	*Bordetella pertussis*	Length:40–100 nm Diameter: 2 nm	Whooping cough	Direct contact or inhalation of airborne droplets
4	*Yersinia pestis*	Length: 1–3 μm Width:0.5–0.8 μm	Pneumonic plague	Being bitten by infected rodent flea or by handling infected animals
5	*Bacillus anthracis spore*	Length: 3–5 μm Width: 1.0–1.2 μm	Anthrax	Contact with infected animals, flies, and the breathing of air containing *anthrax spores*
6	*Variola vera*	Length: 220–450 nm Width:140–260 nm	Smallpox	Inhalation of airborne variola virus, prolonged face-to-face contact with an infected person, direct contact with infected bodily fluids or contaminated objects
7	*Herpesvirida, HHV-3*	Diameter: 150–200 nm	Chickenpox and shingles	Direct contact with fluid from the rash blisters caused by shingles
8	*Morbillivirus measles*	Length: 125–250 nm Diameter: 21 nm)	Measles, mumps, and rubella	Bodily fluids: drops of saliva, mucus from the nose, coughing or sneezing, tears from the eyes, *etc.*
9	*Varibrio Cholerae*	Length: 1.4–2.6 μm Width: 0.5–0.8 μm	Cholera	Bite of contaminated food or a sip of contaminated water
10	*Salmonella Typhi*	Length: 0.7–1.5 μm Thickness: 28 μm	Typhoid	Through contaminated food or water and occasionally through direct contact with someone who is infected
11	*Microsporum Trichophyton*	Length:5–100 mm Width: 3–8 mm	Ringworm	Direct or indirect contact with skin or scalp lesions of infected people, animals or fomites

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