Available online at www.sciencedirect.com

ScienceDirect

Procedia Environmental Sciences 35 (2016) 400 – 407

Procedia Environmental Sciences

International Conference on Solid Waste Management, 5IconSWM 2015

Quantification and Characterization of Size-segregated Bioaerosols at Municipal Solid Waste Dumping Site in Delhi

Smita Agarwal *, Papiya Mandal, Anjali Srivastava

CSIR-National Environmental Engineering Research Institute, Delhi Zonal Laboratory, New Delhi, India

Abstract

Size-segregated aerosol samplings were carried out during 2013-14 at Okhla landfills, Delhi, which is a municipal solid waste dumping station. Aerosol samples were collected on quartz filters using an Andersen impactor sampler having 9-stages with cut-off diameter >9.0, 9.0-5.8, 5.8-4.7, 4.7-3.3, 3.3-2.1, 2.1-1.1, 1.1-0.65, 0.65-0.43, <0.43 µm at flow rate 28.3 lpm. Additionally, a low-volume handy sampler was also used to measure total culturable microbial concentrations operates at flow rate of 2 lpm. The culturable total bacterial and fungal concentrations across the seasons ranged from 8.3×10^5-1.8×10^7 cfu/m^3 and 1.2×10^3-2.5×10^5 cfu/m^3, respectively and also varied across the impactor stages. Major concentration peaks found during winter could be associated with high particulate matter concentration and favourable meteorological conditions in Delhi. On the other hand, comparatively lower concentrations were observed in summer. This is possibly because of microbial lethal effects of adverse meteorological conditions (high temperature and solar radiation) which are more prominent than that of release of microbial flux due to solar ground heating effect in summer. Size distribution analysis shows that bacteria were mostly abundant in fine particle sizes, i.e. <0.43-2.1 µm, but few peaks were also observed in size ranges between 5.8->9.0 µm. Fungal spores mostly peaked in coarse sizes (2.1-5.8 µm) and showed unimodal size distribution. Predominant identified bacterial strains were mostly belonged to Bacillus, Staphylococcus, Streptococcus, Klebseilla and Escherichia genera. Most of the identified fungal spores are known for adverse health effects causing numerous allergic and pathogenic inflammations. These results suggest that the open-solid waste dumping sites are a major source of bioaerosols, and residents living in the nearby areas of landfills are at high health risks.

Peer-review under responsibility of the organizing committee of 5IconSWM 2015

Keywords: Size-segregated bioaerosols, Solid waste dumping site, Bacteria, Fungi;

* Corresponding author.
E-mail address: s_agarwal@neeri.res.in

Peer-review under responsibility of the organizing committee of 5IconSWM 2015
doi:10.1016/j.proenv.2016.07.021

1. Introduction

Municipal solid waste landfills are considered as the potential sources of microorganisms emitted into the environment, where they exist in the form of biological aerosol particles often referred as the bioaerosols (Kazmierczuk et al. 2014 and references therein). The concentration, composition and survival of bioaerosols depend on the factors such as their resistance, meteorological conditions, composition of air/particles, type and location of the source (Marthi et al., 1990; Shantha et al., 2009).

Airborne microorganism emissions from waste dumping sites are related to occupational health and safety as well as environmental hygiene aspects (Kazmierczuk et al. 2014; Kummer et al., 2008; Giusti et al., 2009). They can negatively affect agricultural and public health by acting as pathogenic, allergic and toxic agents. In addition to respiratory tract infections, enteric microorganisms commonly present in dumpling ground may produce intestinal tract infections (Shantha et al., 2009). It has been reported that severe lung diseases and allergies may occur as a result of exposure to organic dust, bacteria, actinomycetes and fungi from municipal waste composting sites (Huang et al., 2002 and references therein). A considerably higher occurrence of chest congestion, flu-like symptoms, itching eyes, itching nose, sore throat and coughing was found among garbage handling workers (Sigsgaard et al., 1994). Reported values of environmental concentrations of fungal and bacterial levels are far above the guidelines values suggested in different countries (Clark et al., 1983; Marchand et al., 1995). In addition to their health effects bioaerosols can also affect atmospheric systems by acting as nuclei on which cloud water droplets and ice particles may form and thus can affect hydrological processes and radiation transfer in the atmosphere (Cox and Wathes, 1995; P¨oschl, 2005).

Bioaerosols usually vary in size from few nanometer to hundreds of micro meter. Viruses typically range from 0.005 to 0.05 μm, while bacterial cells and spores typically range from 0.2 to 30 μm in size. Pollens and plant spores are generally larger in diameters between 10 and 100 μm. However, the respirable size fraction of ≤10 μm is of major concern due to their easiness of dispersion and ability to infiltrate the respiratory system (Cox and Wathes, 1995). The aerodynamic sizes of particles decide their depth of penetration and deposition in the human respiratory system, which in turns determine the possible health effects (Golofit-Szymczak, et al., 2010).

Over population growth and rapid urbanization process in metropolitans in India has lead to the development of residential colonies near dumping grounds and hence exaggerated the health risks. Therefore, a study was performed to examine the seasonal variation of bacterial and fungal aerosols in the Okhla landfill site, Delhi. For the purpose size-segregated aerosols were collected in winter and summer seasons and were analyzed for quantification and identification of bacterial and fungal populations.

2. Methodology

2.1 Site Description and Sampling Details

The aerosol samplings were carried out at Okhla landfills, Delhi which is a municipal solid waste dumping site. Location of sampling site is shown in Figure 1. The samples were collected sequentially in winter (16^{th} Dec., 2013 and 14^{th} Oct., 2014) and summer (5^{th} June, 2014 and 16^{th} July, 2014) seasons. Delhi city (location 28.6100 °N, 77.2300 °E, and 218 m above msl) experiences a monsoon influenced humid subtropical climate with high variations between summer and winter temperature. Apart from temperature swings, the city experiences a very dense foggy weather and low planetary boundary layer (PBL) height conditions during winter.

Aerosol samples were collected on quartz filters (prebaked at 450 ºC for 6 hrs) using an Andersen sampler (Thermo Scientific, USA) having 9-stage with cutoff diameter >9.0, 9.0-5.8, 5.8-4.7, 4.7-3.3, 3.3-2.1, 2.1-1.1, 1.1-0.65, 0.65-0.43, <0.43 μm at flow rate 28.3 lpm and a low-volume handy sampler (APM 821, Envirotech Instruments Pvt. Ltd., India) operates at flow rate of 2 lpm. The instruments were placed at a height of ~ 1.0-1.5 m above the ground level for sampling to simulate aspiration from the human breathing zone. The samplers were run for the duration of 2 hrs during the period of 8.00-14.00 hrs. Before each run, each sampler stage was carefully and thoroughly wiped with 70 % ethanol and allowed to dry.