Potential of Bioaerosol Emission in The Green House Laboratory and Research Laboratory at Environmental Engineering Department

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Abstract. In several countries in the world 24% of total atmospheric particles and 5% - 10% are suspended atmospheric particles are bioaerosols. In Indonesia, bioaerosol studies are mostly carried out in hospitals and school laboratories. The purpose of this research is to calculate potential bioaerosol emission in the research laboratory of the environmental engineering department. The method used is based on literature survey and observation of lab activities during waste composting. Based on our calculation, the bioaerosol flux emission from green house lab was 4.6 – 6.2 $x10^3$ cfu/s for Aspergillus Fumigatus, while for research lab it was 12.45 – 16.65 x 10^3 cfu/s. The emission flux of mesophilic actinomycetes was even bigger. The distribution of bioaerosol at GreenHouse lab declined at 3 m away, while for research lab it declined about 5 m away from the sources. Based on this study, schedule arrangement for the students in these lab is important to minimize bioaerosol exposure.

1 Introduction

Bacteria and fungi in the air tend to assemble into particles of different sizes depending on the source, species, relative humidity, and aerosolization mechanism. In many indoor environments, bacterial and fungal particles are in the range of inhaled sizes (<5 μm) allowing them to penetrate deep in the human respiratory tract. Several studies have shown that exposure to aerosol bacteria and fungi in the indoor environment is associated with non-communicable diseases, including allergies, and respiratory and immunotoxic diseases [1].

Although bioaerosol is everywhere in every habitat, outside air, building material construction and maintenance, the parameters of ventilation, human occupancy, and activities are the main factors affecting bioaerosol at the room level [2]. Based on several studies conducted in several countries in the world it was reported that about 24% of the total atmospheric particles and 5-10% of the total suspended particles are bioaerosols [3]. Humans are the main main source of certain bacteria. Even for fungi, where humans do not appear to be the main source, human activity plays an important role, for example, in shedding particles from clothing or scattering dust that can stick to containing fungal types of bioaerosol [4].

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In Indonesia, bioaerosol studies are mostly carried out in hospitals where there is a lot of potential microbial scattering in the air both in the treatment room, in the food preparation room, in the operating room, in the toilet and in the laundry room. In the educational environment, an area in a laboratory where many studies related to biological processes have the potential to produce bioaerosol continuously in the room. This research is intended to quantify the amount of bioaerosol and analyze the risk of bioaerosol exposure in a laboratory environment in the Department of Environmental Engineering. It is hoped that by knowing this bioaerosol can be mitigated from exposure to bioaerosol for researchers / students in the laboratory of the Department of Environmental Engineering

2 Methodology

This study was carried out in Enviromental Engineering Laboratorium, Diponegoro University, Indonesia. Two labs namely GreenHouse Lab and Research Lab were chosen for this research due to a lot of composting research in these labs. In the green house lab, there are 2 buckets for composting in the Green House. The diameter of the bucket is 60 cm and height 20 cm. Those bucket is in identical size. Then, the volume of the green house lab is (length x width x height) = 4 x 4 x 3 = 48 m^3. In the research laboratory, there are 1 box consist of 16 containers, each container has a length of 30 cm, width of 30 cm and height of 40 cm, then the volume of the box which is 16 x 25 x 37,5 x 40 = 600.000 cm^3, so the volume of the box is 600 liter (See Fig.1). The volume of the research laboratory is (length x width x height) = 4 x 4 x 3 = 48 m^3. In this lab, composting is the main activities thus we assume from this process the bioaerosol will be released. We used specific bioaerosol emission rate (SBER) adopted from [5] for bioaerosol emission factor for composting.

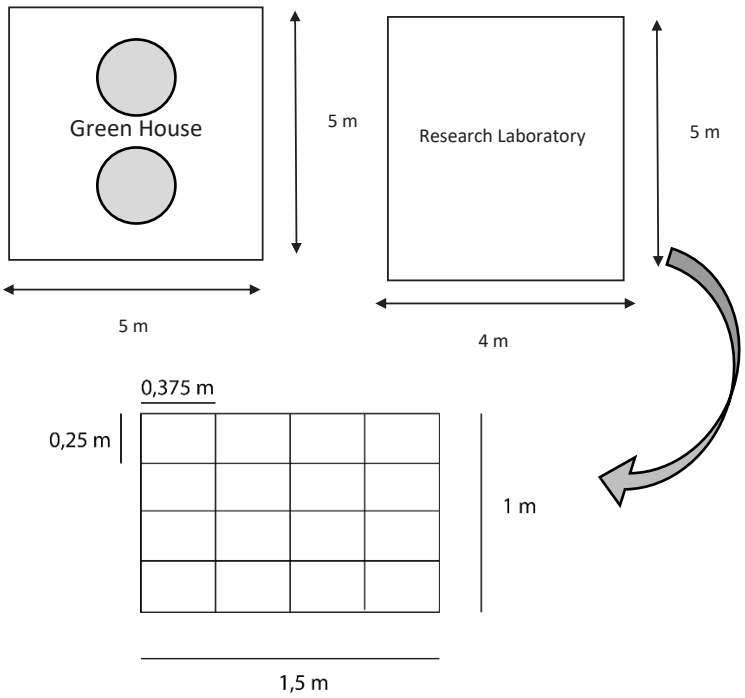


Fig. 1. Size of green house, research laboratory, and bioaerosol container

3 Results and Discussion

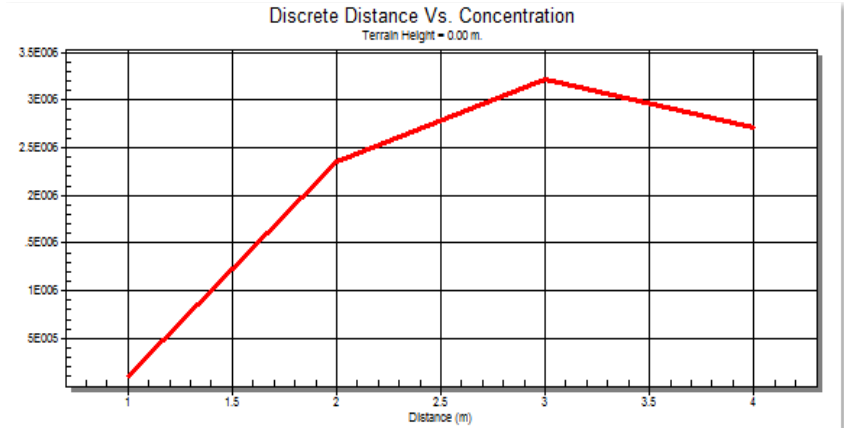
The bioaerosol of interest based on literature study are aspergillus fumigatus (AF) and mesophilic actinomycetes (MA). Based on the calculation results with the theoretical value of SBER the following bioaerosol emission potentials are obtained.

Location	Unit	Area (m^2)	Unit per area ($x10^3$ cfu/s)		Total emission ($x10^3$ cfu/s)	
			AF	MA	AF	MA
Green house	2	0.286	2.34 – 3.13	3.7 – 6.132	4.69 -6.27	7.40 – 12.27
Research Lab	16	0.0938	0.78 – 1.04	1.23 – 2.03	12.45 – 16.65	19.65 – 32.55

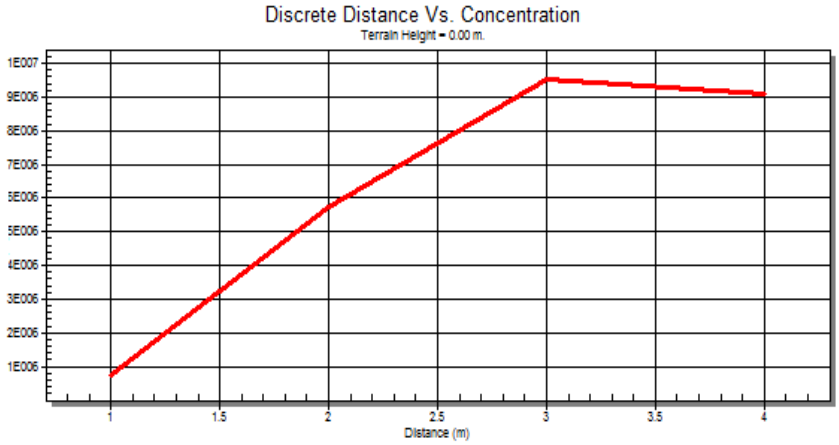
Using SBER : AF : 8.3 – 11.1 ($x10^3$ cfu/s), MA : 13.1 – 21.7 ($x10^3$ cfu/s)

Bioaerosol emissions in the research lab are higher because in this lab, many chambers are used for composting.

The large number of student activities that enter and exit the lab will lead to potential exposure to bioaerosol. Moreover, students are not equipped with PPE to protect their breathing. If we inspect from the aerosol distribution using ScreenView software, we obtain the range of bioaerosol from the composting source as shown in the following figure:



(A)



(B)

Fig. 2. Distribution of AF at Green House Lab (A) and Research Lab (B)

The concentration of bioaerosol (AF) at a height of 75 cm in the GreenHouse and Research Lab ranges from 7.4 - 90 x10^6 cfu /m^3. However the bioaerosol concentration in GreenHouse lab started to decline at 3 m, while at research lab it declined after 5 m from the source. This means the bioaerosol emission at research lab should be carefully controlled to prevent bioaerosol exposure to the students.

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