Characterization of the bacterial and fungal bioaerosols in three elementary schools in Kaohsiung

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Introduction

Recently, indoor air quality (IAQ) including bioaeorosls at school had drawn much attention by people. In South Taiwan, the average temperature and total cumulative rainfall in 2009 is 23.7℃ and 1756.3 mm. It's a great environment for fungi and bacteria. Therefore, we tried to characterize the distribution of the fungal and bacterial bioaeorosols in classrooms in three elementary schools in Kaohsiung and their determine factors.

Materials and Methods

Three primary schools, industrial, traffic, and reference school, were selected to assess PM_{10}, $PM_{2.5}$, and PM_1 concentration. The distance between EPA's Monitoring Station and industrial, traffic, and reference school, is about 300 m, 0 m, and 537 m, respectively.

Nine classrooms of each school to a total number of 62 classrooms was evaluated both indoor and outdoor during April 13th to Jun 13th and September 18th to October 16th , 2009. Bacterial and fungal bioaerosols were sampled at 8 am and 3 pm（MAS-100 ; MERCK, USA）and cultivated in Tryptic soy agar（TSA）and Malt extract agar（MEA）, respectively. Colony-Forming Unit (CFU) after 24hr and 48hr were counted for bacteria and fungi, respectively.

Results and Discussion

The average concentration of bacterial bioaerosols

Inside classroomsin traffic, industry, and reference school was 960±492 CFU/m^3 (means±S.D), 879±1042 CFU/m^3, 1769±1545 CFU/m^3,respectively, whereas the average concentration of bacterial bioaerosols outside classrooms was 640±394 CFU/m^3, 296.5±111 CFU/m^3, 940.6±1026 CFU/m^3 , respectively (table1). It was shown that indoor concentration was higher than the outdoor concentration in most cases. The percentage of higher indoor bacterial concentration was 80%, 66.67%, and 77.78% in traffic, industry, and reference school, respectively. Table2 showed the I/O ratio of bacterial bioaerosols. The average I/O ratio of three schools was all higher than 1. It may be affected by whether the classrooms near the restrooms and stairs. For fungal bioaerosols, the average indoor concentration at traffic, industry, and reference school was 505±248 CFU/m^3 (means±S.D), 323±156 CFU/m^3 and 1658±1258 CFU/m^3, respectively, whereas the average concentration of bacterial bioaerosols outside classrooms was 473±309, 283±159, 1510±799 (teble1), respectively.

Similar trend was observed for both fungi and bacteria. The percentage of the higher indoor fungal bioaerosols at traffic, industry, and reference school, was 75%, 30%, and 66.67% respectively. Table2 Showed the I/O ratio of fungal bioaerosols.In comparison with the guideline value of IAQ in Taiwan, the the rate of classroom above the standard of bacterial bioaerosols at traffic, industry, and reference school was 19.05%, 0%, and 28.57%, respectively, and the failure rate of fungal bioaerosols was 9.52%, 5%, and 85.17%, respectively.

Table1. The Descriptive statistics and the rate of classroom exceed the guideline of Taiwan EPA

		Mean	Median	Std.	Min.	Max.	Above the standard
Indoor bacteria (CFU/m^3)	Traffic	960	713	492	286	1993	90%
	Industry	879	493	1042	241	4293	45%
	Reference	1769	1123	1545	218	5650	85.7%
Outdoor bacteria (CFU/m^3)	Traffic	640	582	394	149	1608	
	Industry	296	270	111	160	533	
	Reference	940	640	1026	170	4949	
Indoor fungi (CFU/m^3)	Traffic	505	435	248	171	945	0%
	Industry	323	319	156	81	636	0%
	Reference	1658	1353	1258	475	5725	66.7%
Outdoor fungi (CFU/m^3)	Traffic	473	416	309	128	1396	
	Industry	283	230	159	67	674	
	Reference	1510	1230	799	377	3860	

Table2. I/O ratio of traffic, industry, and reference school in the morning and afternoon

		Morning					Afternoon				
	School(N)	Mean	Median	Std.	Min.	Max.	Mean	Median	Std.	Min.	Max.
Bacteria	Traffic (21)	2.2	1.9	1.5	0.1	5.8	3.0	1.8	4.6	0.3	21.2
	Industrty (20)	3.5	1.7	5.5	0.4	25.8	2.5	1.2	3.5	0.5	3.7
	Reference (21)	3.9	2.59	4.9	0.3	22.4	1.7	1.4	1.3	0.2	4.9
Fungi	Traffic (21)	1.2	1.1	0.6	0.2	2.4	1.5	1.4	0.9	0.2	3.1
	Industrty (20)	1.4	1.0	0.9	0.5	16.0	2.0	1.2	3.1	0.3	14.7
	Reference (21)	1.4	1.1	1.14	0.1	5.3	1.2	1.0	0.7	0.3	2.7