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HEAVY METAL IN PM10 IN THE BUILDINGS OF CHIANG MAI PROVINCE DURING SMOG CRISIS

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Graphical abstract

Abstract

The objective of this research is to study of concentration of heavy metals such as manganese, copper, iron, silver; cadmium, chromium, nickel and lead in particulate matter size smaller than 10 micron (PM10) samples were collected from five building in Chiang Mai province during smog crisis. The PM10 samples were collected by a PM10 low volume air sampler dust with the flow rate 1.7 liter per minute. The sampling time was set 8 hours for each sample according to the sampling from December 2012 to May 2013. The composite elements, i.e., Manganese (Mn) Copper (Cu) Iron (Fe) Silver (Ag) Cadmium (Cd) Chromium (Cr) Nickel (Ni) and lead (Pb) analyzed by Flame Atomic Absorption Spectrophotometer (FAAS). It was found that the indoor dust value of 12.25-171.57 microgram per square meter per day. The most of indoor dust samples were not exceeded the standard value of 150 microgram per cubic meter. The heavy metal concentration were not exceeded the air quality standard value.

Keywords: PM10, heavy metal, indoor air, Smog crisis, Chiang Mai province

1.0 INTRODUCTION

At present, the traffic in Chiang Mai city is quite dense. There are private cars, buses, and motorcycles. Therefore, it increases environmental impacts and, importantly, causes the problem of the particulate matter that is dust in the air. This problem affects the respiratory system and human health. The other air pollution sources are burning of paddy fields and forests which are main sources of the smog crisis in this province. Moreover, this dust can be an important accumulated source of heavy metals in the environment. Some heavy metals have adverse effects whereas other heavy metals are essential to human health but can be toxic if taken in excess quantity [1-3]

As a guideline for the study of environment in the habitation and a guideline for the risk assessment of people's health in the area of Chiang Mai city, this research emphasized on the study of the quantity of toxic and non-heavy metals which were manganese (Mn) Copper (Cu) Iron (Fe) Silver (Ag) Cadmium (Cd) Chromium (Cr) Nickel (Ni) and lead (Pb) in PM10 and the study of the quantity of PM10 in area of Chiang Mai areas.

2.0 EXPERIMENTAL

Studied locations: collected the in natural ventilated buildings on five locations, e.g., the first site at southern part of Chiang Mai city (Chiang Mai – Lamphun Road), the second site at middle part of Chiang Mai city (Thapae Gate), the third site at western part of Chiang Mai city (Chiang Mai University), the fourth site at eastern part of Chiang Mai city (Sankampheang District), the fifth part site at northern part of Chiang Mai city (Mae Rim District), which set in the residential areas as shown in Figure 1. The PM10 samples were collected by a PM10 low volume air sampler dust with the flow rate 1.7 liter per minute. The sampling time was set 8 hours for each

sample according to the sampling from December 2012 to May 2013.

Figure 1 Map of sampling sites in Chiang Mai city

Studies parameters and sample analysis

(1) The concentration of the dust of which PM10 was analyzed by Gravimetric Method.

(2) The Manganese (Mn) Copper (Cu) Iron (Fe) Silver (Ag) Cadmium (Cd) Chromium (Cr) Nickel (Ni) and lead (Pb) were analyzed by Flame Atomic Absorption Spectrophotometer (FAAS).

3.0 RESULTS AND DISCUSSION

3.1 Concentration of PM10 in Chiang Mai Indoor Air Environment

The statistical summary of the PM10 data from five buildings in Chiang Mai across the period December 2012 to May 2013 is show in Table 1. At Chiang Mai – Lamphun Road site the data maximum value of 73.53 microgram per cubic meter, on January 2013. The data minimum value of 12.25 microgram per cubic meter, recorded on December 2012, February 2013 and May 2013. At Thapae Gate site the data maximum value of 110.29 microgram per cubic meter, on April 2013. The data minimum value of 24.51 microgram per cubic meter, recorded on May 2013. At Chiang Mai University site the data maximum value of 147.06 microgram per cubic meter, on April 2013. The data minimum value of 12.25 microgram per cubic meter, recorded on December 2012. At Sankampheang District site the data maximum value of 171.57 microgram per cubic meter, on March 2013. The data minimum value of 12.25 microgram per cubic meter, recorded on December 2012. At Mae Rim District site the data maximum value of 147.06 microgram per cubic meter, on March 2013. The data minimum value of 12.25 microgram per cubic meter, recorded on December 2012 and April 2013. The most of dust concentrations were not exceeded the standard value of 150 microgram per cubic meter (4)

Table 1 The PM10 data from five buildings in Chiang Mai

Month	PM10 Sampling	Sampling sites				
		Chiang Mai – Lamphun Road	Thapae Gate	Chiang Mai University	Sankampheang Distric	Mae Rim District
Dec 2012	Frist	12.25	24.51	24.51	12.25	24.51
	Second	12.25	36.76	12.25	98.04	12.25
	Average	12.25	30.64	18.38	55.15	18.38
Jan 2013	Frist	36.76	24.51	61.27	36.76	24.51
	Second	73.53	98.04	24.51	24.51	24.51
	Average	55.15	61.27	42.89	30.64	24.51
Feb 2013	Frist	24.51	49.02	24.51	24.51	36.76
	Second	12.25	24.51	36.76	12.25	36.76
	Average	18.38	36.76	30.64	18.38	36.76
March 2013	Frist	24.51	36.76	61.27	122.55	110.29
	Second	24.51	36.76	49.02	171.57	147.06
	Average	24.51	36.76	55.15	147.06	128.68
April 2013	Frist	61.27	73.53	73.53	122.55	134.80
	Second	49.02	110.29	147.06	61.27	12.25
	Average	55.15	91.91	110.29	91.91	73.53
May 2013	Frist	24.51	24.51	49.02	36.76	36.76
	Second	12.25	49.02	12.25	49.02	49.02
	Average	18.38	36.76	30.64	42.89	42.89

3.2 The Heavy Metal in PM10 Samples

The standards of heavy metal in the air environment of National Institute for Occupation Safety and Health (NIOSH) in 2007 are show in Table 2

Table 2 The standard of heavy metal in the air environment

Heavy Meal	The standard in the air (mg/m^3; 8 hrs.)
Manganese (Mn)	5
Copper (Cu)	1
Iron (Fe(	1
Silver (Ag)	0.1
Cadmium) Cd)	0.005
Chromium (Cr)	1
Nickel(Ni)	1
Lead (Pb)	0.05

Source: National Institute for Occupation Safety and Health (NIOSH), 2007 (5)

The statistical summary of the heavy metal in PM10 data from 5 buildings in Chiang Mai across the

period December 2012 to May 2013 is show in Table 3.

Mn; The statistical summary of the manganese in PM10 data from five building sites in Chiang Mai across the period December 2012 to May 2013 is show that the manganese data maximum value of 0.84 microgram per cubic meter at Chiang Mai – Lamphun Road and Sankampheang Distric site. The data lower than the standard of heavy metal in the air environment. Manganese makes up about 1000 ppm (0.1%) of the Earth's crust, making it the 12th most abundant element there. Soil contains 7–9000 ppm of manganese with an average of 440 ppm. Seawater has only 10 ppm manganese and the atmosphere contains 0.01 µg/m3. [6] Methylcyclopentadienyl manganese tricarbonyl (MMT) is a gasoline additive used to replace lead compounds for unleaded gasoline, to improve the octane number in low octane number petrol distillate in developed countries (EU, Japan, etc.). In USA the imperative to provide the lowest possible price per volume on motor fuels (low fuel taxation rate) and lax legislation of fuel content (before 2000) caused refineries to use MMT. Compared to 1953, levels of manganese in air have dropped. [7]

Ag; The statistical summary of the silver in PM10 data from five building sites in Chiang Mai across the period December 2012 to May 2013 is show that the silver data maximum value of 0.67 microgram per cubic meter at all sites. The data lower than the standard of heavy metal in the air environment. Silver plays no known natural biological role in humans, and possible health effects of silver are a disputed subject. [8] Silver itself is not toxic to humans, but most silver salts are. In large doses, silver and compounds containing it can be absorbed into the circulatory system and become deposited in various body tissues, leading to argyria, which results in a blue-grayish pigmentation of the skin, eyes, and mucous membranes. Argyria is rare, and although, so far as known, this condition does not otherwise harm a person's health, it is disfiguring and usually permanent. Mild forms of argyria are sometimes mistaken for cyanosis [9].

Cu, The statistical summary of the Copper in PM10 data from five building sites in Chiang Mai across the period December 2012 to May 2013 is show that the silver data maximum value of 3.17 microgram per cubic meter at Chiang Mai – Lamphun Road and Chiang Mai University. The data lower than the standard of heavy metal in the air environment at 1 milligram per cubic meter.

Fe, The statistical summary of the iron in PM10 data from five building sites in Chiang Mai across the period December 2012 to May 2013 is show that the silver data maximum value of 99.25 microgram per cubic meter at Chiang Mai – Lamphun Road. The data lower than the standard of heavy metal in the air environment at 1 milligram per cubic meter.
Cadmium (Cd) Chromium (Cr) Nickel (Ni) and lead (Pb) cannot detect in these experiment.

Table 3 The Heavy Metal in PM10 data from five buildings in Chiang Mai (microgram per cubic meter)

Heavy Metal	PM10 Sampling	Sampling sites				
		Chiang Mai – Lamphun Road	Thapae Gate	Chiang Mai University	Sankam-pheang Distric	Mae Rim District
Mn	Max	0.84	0.63	0.63	0.84	0.63
	Min	0.00	0.00	0.00	0.00	0.00
	Average	0.35	0.32	0.27	0.30	0.29
Ag	Frist	0.67	0.67	0.67	0.67	0.67
	Second	0.29	0.29	0.29	0.29	0.29
	Average	0.42	0.45	0.45	0.45	0.45
Cu	Frist	3.17	2.68	3.17	2.68	2.68
	Second	0.15	0.15	0.15	0.15	0.15
	Average	0.99	1.04	1.08	0.95	1.00
Fe	Frist	99.25	69.13	52.25	58.78	68.57
	Second	27.70	25.00	25.98	25.02	24.83
	Average	52.99	39.90	38.25	39.37	40.04

4.0 CONCLUSION

The sampling time was set 8 hours for each sample according to the sampling from December 2012 to May 2013. The composite elements, i.e., Manganese (Mn) Silver (Ag Copper (Cu) Iron (Fe)) were not exceeded the air quality standard value. Cadmium (Cd) Chromium (Cr) Nickel (Ni) and lead (Pb) cannot detect from this research. The indoor dust samples were value of 12.25-171.57 microgram per square meter per day. The most of indoor dust samples were not exceeded the standard value of 150 microgram per cubic meter.

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