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Metals Composition in Low Cost Apartment in Kuala Lumpur

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ABSTRACT

House dust was found to be a great indicator of metal pollutants for indoor air quality. This study aims to assess the level of metals in house dusts and identify the relationship between the composition of metals concentration in low cost apartment, Kuala Lumpur. Eight houses were selected randomly from four levels of low cost apartment buildings. The samples were collected using a brush and plastic pan and then the samples were digested. The compositions of metals were determined using Inductively Coupled Plasma-Optical Emission Spectrometer (ICP-OES) and statistical analysis was used to analyze the data by using Statistical Packages for the Social Sciences (SPSS). The results show that the highest concentration of metals obtained was Fe with the mean value of 1483.64 mg/kg followed by Zn with the mean value of 1197.07 mg/kg, while Cd recorded as the lowest mean value of 0.131 mg/kg. The trend distribution of metals in the investigated areas followed the order Fe > Zn > Cu > Pb > Cd. Statistical analysis indicates significant correlation between all the possible pairs of metals.

Keywords: *Metals composition; Houses; Indoor dust; Correlation analysis*

INTRODUCTION

The urbanization and industrialisation in Malaysia has been fastest growing over the past two decades [1]. The increasing levels of the pollution in the surrounding area may contribute from the rapid growth of the industry, population, and transportation which includes metals in dust [2]. Metals in dust also included in the contribution to the increased pollution levels at the surrounding areas [3]. This cause a serious problem as metals in dust is a strong indicator of the elevation levels of environmental pollution especially in the urban area [4]. The content of metals in house dust has become the social concern [5].

House dust may be more hazardous than the direct ingestion of soil due to the higher levels of harmful substances in it compared with the soil at the source [6, 7]. In general, the contribution of exterior soil to house dust is estimated to be between 20 and 80%, depending on the surrounding environmental

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conditions and geographic locations [8, 9]. Moreover, dust particles are considered as transport and exposure media for many types of hazardous pollutants [10, 11]. Dust can originate either from internal or external sources [1]. Interior sources include the emissions from building furnishing and decorative supplies such as wall paint, wood products, carpets, and furniture made from certain pressed wood products, cooling and humidification devices [12]. As for the exterior sources, this generally includes automobile exhaust, traffic emission and industrial sources [13, 14].

Metals are among the most important pollutants in urban environment, and becoming a severe public health problem due to their acute toxicity and carcinogenicity [15]. Household dust is heterogeneous and complex mixture of organic and inorganic particles which could absorb and accumulate metals [14] and it is reported that adults and children have spent more than 75 % of the day time stay at indoor environment, respectively [16]. Dust particles are well established to contain higher concentrations of potentially toxic metals [17]. Intake of house dust by children and adults can occur through several pathways and activities such as hand-to-mouth, eating food dropped on floor, or to a lesser extent, ingestion via mouth inhalation and skin absorption [9, 18].

The majority of adults spend more than 80% of the day in a variety of indoor environments, mainly in their houses [19]. Therefore, household dust maybe a major pathway of metals exposure to the residents [20]. In Malaysia, there are guidelines (code of practice on indoor air quality) for indoor air quality and exposure standards to protect workers but no guidelines have yet been developed that apply specifically to the domestic environment such as in residential building [1]. In order to provide a healthy city environment and protect lives from metal contaminants, it is important to have a thorough understanding of the extent of metal pollutants in residential buildings. Therefore, the aim of this study is to assess the level of metals in house dusts and identify the relationship between the composition of concentration in low cost apartment, Kuala Lumpur.

EXPERIMENTAL

Study Area

Pantai Dalam is a residential area located at the south-west of Kuala Lumpur. Program Perumahan Rakyat (PPR) Kerinchi is one of the projects under People's Housing Project of low cost high rise flats developed by the National Housing Department (Jabatan Perumahan Negara or JPN) in Kuala Lumpur, since 1998 [21]. Eight houses in PPR Kerinchi were chosen as sampling sites. These low cost apartments are located in the city center, along major thoroughfares as well as near to constructions. The sampling was conducted from February to march 2019. Table 1 shows the site description of selected houses.

Table 1: Site description of the houses

Code[#*]	Number of Occupants	Number of Windows
H1	4	4
H2	5	4

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H3	5	4
H4	6	4
H5	4	4
H6	2	4
H7	4	4
H8	5	4

[#] Land use background: Urban area, closed to main road and constructions
[*] Ventilation Condition: Ceiling fan, natural ventilation all the time

Sample Collection

Dust samples were taken from eight houses in different levels of the low cost apartment randomly using a brush and plastic pan. The samples that were transferred into a clean reseable plastic bag, brought to the laboratory of Faculty of Applied Sciences, UiTM Shah Alam and placed in an empty desiccator for 24 hours, sieved through a stainless steel 100 mesh screen sieve. And finally, oven dried for 24 hours at temperature of 105 ^{o}C.

Sample and Data Analysis

After drying, about 0.3 - 0.5 g of the fine portion of the dust was then digested by using 3 mL of mixture solution (HCl-HNO_3-H_2O) in a ratio of 2:2:2 to form aqua regia acid at 95 ^{o}C for at least one hour until white fumes appeared. Then, the extract was cooled and filtered through Whatman No. 42 filter papers. The filtrate was then made up to a volume of 50 mL in the volumetric flask with distilled water and was analyzed for metal content by using Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES) in order to determine the concentration of Al, Ba, Cr, Cu, Fe, Ni, Pb and Zn metals.

The blank experiment was carried out by repeating the procedure for sample preparation without the sample. The composition of the blank solution was compared with the sample solution to identify the elemental composition of metals in the dusts. The data were analyzed using statistical functions in Statistical Packages for the Social Sciences (SPSS), including factor analysis and correlation functions. The outcomes of data were shown in form of chart and graph.

Instrumentation

Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES, Optima 5300 DV; Perkin Elmer) and all chemicals by Fisher Scientific (M) Sdn. Bhd.

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RESULTS AND DISCUSSION

Metals concentration

The mean concentration of metals in the indoor dust samples at a low cost apartment building in Kuala Lumpur are summarized in Table 2. The highest concentration of metals obtained was Fe with the mean value of 1483.64 mg/kg followed by Zn with the mean value of 1197.07 mg/kg. Fe are abundant elements in the Earth's crust [22, 23] while Zn related to automobile emission [24]. Fe was the highest concentrations for this study because the locations of all nursery schools were close to the main road with high traffic density and therefore it is expected to contain high Fe. These elements have been produced by alteration (friction) and distributed or transported via wind blow and can be associated with soil or street dust [25].

However, Cd recorded as the lowest (0.131 mg/kg) among all the metals at the low cost apartment, Kuala Lumpur. The sources of Cd in dust are believed to be from activities such as mining, phosphate fertilizer, manufacturing, cement production of nonferrous metal and waste incineration [26]. The metals concentration in the investigated area followed the order of Fe > Zn > Cu > Pb > Cd based on their mean concentrations. The indoor sources such as by the presence of deteriorated or damaged paint of the old houses, carpet and furnishing may also have contributed to the lead concentration in settled dust [27]. The location of the houses which are closed to main road with high traffic density may have contributed to the presence of Zn in the dust [28].

Table 2: Descriptive statistics of indoor dust metal concentration (mg/kg) (N=8)

Metals (mg/kg)	Mean	SD	Min	Max
Cd	0.062	0.05	0.015	0.13
Cu	29.06	13.10	10.20	52.04
Pb	7.63	4.38	2.10	16.96
Zn	701.03	338.92	174.71	1197.07
Fe	917.28	366.92	304.19	1483.64

SD – Standard deviation

Correlation Coefficient Analysis

The Pearson's correlation coefficient can be used to estimate degree of correlation between metals data logarithms. The correlation matrix for metals at the low cost apartment, Kuala Lumpur are summarized in Table 4.1. Statistical analysis indicates positive relation between all the possible pairs of metal at 99% and 95% or higher confidence level. High positive correlation which were significant at 95% and/or higher confidence level was found between Fe-Cd (r = 0.711) and Zn-Cu (r = 0.790). While, pair of Fe-Pb (r = 0.848) significantly correlated with each other at 99% or higher confidence level, which may indicate a common sources origin, such as automobile emission, street dust and other related activities.

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The strong and positive correlations among Fe and Pb nmight indicate that they could have come from the same sources, such as road traffic, as these metals are contained in motor vehicles. The study by Al-Khashman (2004) revealed a high correlation of the metal concentrations of Cu, Fe, Pb, and Zn which convinced him that anthropogenic activities are the main sources of heavy metal in soils.

Table 3: Correlation matrix for the metals concentration

	Cd	**Cu**	**Pb**	**Zn**	**Fe**
Cd	1.000				
Cu	0.015	1.000			
Pb	0.690	0.479	1.000		
Zn	-0.268	**0.790***	0.122	1.000	
Fe	**0.711***	0.499	**0.848****	0.285	1.000

* $p < 0.05$

** $p < 0.01$

CONCLUSIONS

The present data showed the metals of Fe, Zn, Cu, Pb and Cd were found in low cost apartment, Kuala Lumpur. The results show the highest concentration of metals was Fe (1483.64 mg/kg) and the lowest was Cd (0.131 mg/kg). The metals concentration in the investigated area followed the order of Fe > Zn > Cu > Pb > Cd. Data analyses indicate that abundant elements in the earth's crust and automobile emission may be the major source of these metals in indoor dust.

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