ZANCO Journal of Pure and Applied Sciences
The official scientific journal of Salahaddin University-Erbil
https://zancojournals.su.edu.krd/index.php/JPAS

ISSN (print):2218-0230, **ISSN (online):** 2412-3986, **DOI: http://dx.doi.org/10.21271/zjpas**

RESEARCH PAPER

Determination of Some Heavy Metals in Environment of Bakery and Samoon Furnaces at Erbil City, Kurdistan Region, Iraq

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ABSTRACT:

This study was investigated for the assessment of dust contamination with some heavy metals in Naans bakery and Samoon furnace environment and to indicate their potential sources of origin. Fifteen locally Naans bakery and Samoons furnace places were chosen for sampling of accumulated residue dust and heating fuel in Erbil city, Kurdistan Region, Iraq. Naan bakeries used liquefied gas (NGB) for heating while Samoon furnaces used liquefied kerosene (OSF) or liquefied gas (GSF) as heating source. The wet acid digestion method was applied for the sample treatment using a mixture of concentrated perchloric acid ($HClO_4$ 70%), hydrochloric acid (HCl 37%), and nitric acid (HNO_3 65%) with a volume ratio (1:1:2). The analyses were carried out using flame atomic absorption spectrometer to determine some selected heavy metals (Cu, Cr, Cd, and Ni). The results showed that the recorded percentage for observed metals (OM) from the entire of the investigated dust samples (n=15) were different and individually equal to 20%, 60%, 93.3%, and 100% for each of Cd, Cr, Ni, and Cu respectively. The level of metals content in most of dust samples exceeded standard permissible limits for metals in dust environment. The recorded level for total selected metal load (TSML) in dust samples of NGB environment (392.23 $\mu g \cdot g^{-1}$) was approximately twice times more than each of the OSF (207.45 $\mu g \cdot g^{-1}$) and GSF (211.31 $\mu g \cdot g^{-1}$) environment. Results data showed that the environment of most bakery Naan and Samoon furnace was unsafe for baking and contaminated with these heavy metals.

KEY WORDS: Heavy Metals; Dust; Samoon Furnace; Naan Bakery; FAAS; Erbil City
DOI: http://dx.doi.org/10.21271/ZJPAS.32.3.18
ZJPAS (2020) , 32(3);176-186 .

1. INTRODUCTION

Heavy metals are among noteworthy pollutants in municipal environment, and getting to be an intensive public health problem due to their extreme toxicity and carcinogenicity (Wei and Yang, 2010). Humans are exposed to the threat of metals throughout numerous pathways because these metals are widely distributed in the environment and originated from both human activities and natural sources (Abd-Alhameed, 2019, Darwesh, 2019).

There are several distribution sources of heavy metals in the environment including natural weather conditions of the earth's crust, soil erosion, industrial effluents, sewage discharge, mining, urban runoff, applying control agents on crops disease or insects, heating sources and many others. The wide distribution of heavy metals in the human environment can also be referred from extensively chemical applications in industries, agriculture, medicine, homes, and more others (Morais et al., 2012, Yang and Massey, 2019, Abd-Alhameed, 2019, Darwesh, 2019)

Most heavy metals have confirmed to be a toxic and major health risk linked with them because they tend to be bioaccumulated inside organ

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Article History:
Received: 07/03/2020
Accepted: 19/05/2020
Published: 15/06 /2020

tissues (Al-Attar, 2016, Bazzaz and Muhammad, 2018). They sometimes act as interfere with the human metabolic processes and are harmful to their body. The absorbed dose, exposure duration and the way of exposure of metals by the human body are the main factors to be metal toxicity. Human inhalation, ingestion, and dermal absorption are known as main exposure routes for heavy metals contact (Jaishankar et al., 2014). Some metals are harmful, get accumulated in the body and have several health risks. Metals toxicity can cause a variety of disorders and damage human organs throughout oxidative stress produced by free radical formation. Some chronic problems linked with long-term heavy metal exposures are metal lapse caused by lead exposure. Besides, cadmium has effects on the liver, kidney and gastrointestinal tract (Lu et al., 2010). The implications of metals toxicity consequences on children’s health have been distinguished to be more severe compared to adults. The consequence risks of these elements’ toxicity on children's health include behavioral disorders, neurocognitive disorders, mental retardation, respiratory problems, cardiovascular and cancer diseases (Jaishankar et al., 2014, Yang and Massey, 2019).

One of the imperative pathways of insinuation to heavy metal for humans is through suspended or residue dust in the environment. Dust is generally defined as a solid matter composed of soil, natural biogenic and anthropogenic metallic constituent materials (Ferreira-Baptista and De Miguel, 2005). Assessment of Cd, Cu, Cr, Pb, Ni, and Zn heavy metals' level and distribution in dust samples around our environment such as indoors, outdoors, streets, schools, markets, agricultural fields, and working places have recently received much attention. Thus, researchers have extensively concerned this issue through analysis of various environmental samples to assess their characteristics and health risk assessment exposure to the human (Abd-Alhameed, 2019, Amin et al., 2017, Cheng et al., 2018, Darwesh, 2019, Jin et al., 2019, Khudhur et al., 2016, Zgłobicki et al., 2018, Zhou et al., 2019).

Crude oils are generally defined as a complex mixture of inorganic and organic matter. Presenting heavy metals in crude oils can be categorized as inorganic compounds (Sainbayar et al., 2011). The presence of trace metals level can be used to classify the quality of crude oils in terms of residual, light, medium, and heavy fraction (Barbooti et al., 1986). The refining treatment of heavy crude oil is a constable in comparison to light crude oil due to the high content of metals content (Reynolds, 2003). Investigation of heavy metals content in crude oils, products and their environment has been widely conducted by researchers. The uses of inappropriate crude oil as heating sources can be selected as polluted sources with heavy metals ongoing to spreading and pre-concentration of their residue dust in the environment (Barbooti, 2015, Jadoon et al., 2016, Roldan et al., 2004, Darwesh, 2019).

Refractory bricks which are the most important type of bricks, also called fire brick or firebrick (FB) can withstand to the elevated temperature (Edwards, 2019). Firebricks play an important role as materials of heat/energy storage and resistance which have also been used with kerosene fuel in the waste heat recovery by bakers in Erbil city. Many recent studies verified that brick kilns and manufactures are commonly known as one of the most main sources of soil, air, and water pollutants with heavy metals (Issa et al., 2019, Proshad et al., 2017, Sikder et al., 2016)

According to many studies investigation, main anthropogenic sources including industrial, traffic and domestic emission, atmospheric deposited, weathering of pavement, and more others are the main pollution sources of heavy metals for municipal dusts in the environment (Abd-Alhameed, 2019, Amin et al., 2017, Darwesh, 2019, Khudhur et al., 2016, Sezgin et al., 2004). According to Fabis (1987), world permissible limits for some heavy metals such as Hg, Cd, Cu, Ni, Co, Pb, Cr and Zn in soil and dust samples are 2, 3, 50, 50, 50, 100, 100 and 300 $\mu g \cdot g^{-1}$ respectively. It is known that, based on income, availability and waste heat recovery, firebricks and low quality kerosene fuel have been randomly used as a heating source by some bakers and furnaces owner in Erbil city, Kurdistan Region, Iraq. Considering the above and based on human health safety, the main objective of this study is to determine some heavy metals in the Naan bakery and Samoon furnace environment for the first time. Besides, the content of the selected metals in the used heating sources is investigated to know sources of pollutants.

2. MATERIALS AND METHODS

2.1. Chemicals

All the used chemicals were of analytical grades including nitric acid (HNO_3 65%), hydrochloric acid (HCl 37%), and perchloric acid ($HClO_4$ 70%). According to AAS manufacturer guideline (Whiteside and Milner, 1984) chromium nitrate $[Cr(NO_3)_3.9H_2O]$ and nickel nitrate $[Ni(NO_3)_2.6H_2O]$ were used and dissolved in distilled water throughout the experiments for the preparation of 1000 mg/kg of Cr and Ni stock solutions respectively. Chemicals such as CdO (dissolved in 5M diluted HCl) and Cu metal (dissolved in 5M HNO_3) were also used to prepare 1000 mg/kg of Cd and Cu stock solutions respectively. Then, serious working solutions for the selected of the metals ion were individually prepared from the stock solutions using distilled water.

2.2. Instruments

Sensitive Balance (KERN & Sohn GmbH), Box Furnace (Gallenkamp Size 1), Classic Digestion-Heater (Gerhardt) and digestion Kjeldal's flask were used for weighting and the sample digestion process. Flame atomic absorption spectrometer (FAAS) (Pye-Unicam SP9 model flame AAS, Cambridge, CB, UK) accoutered with a hollow cathode lamp as the light source and acetylene-air flame burner was used to determine selected metal ions in whole sample solutions. The instrumental parameters and optimum conditions were those suggested by the manufacturer guideline (Whiteside and Milner, 1984). The wavelengths (nm) selected for the determination of the metals ion were as follows: Cd, 228.8 nm; Cr, 357.9 nm; Cu, 324.8 nm; and Ni, 232.0 nm. Acetylene (C_2H_2) flow rate was 0.8-1.4 $mL{\cdot}min^{-1}$ and air flow rate was 18-28 $mL{\cdot}min^{-1}$. The nebulizer uptake rate was 6 $mL{\cdot}min^{-1}$. The hallow cathode lamp currents were 5, 8, 12, and 15 mA for Cu, Cd, Cr, and Ni respectively.

2.3. Study Area and Sample Collection

During sample collection, fifteen locally Naan bakery, and Samoon furnace environments were selected from different places in Erbil city, Kurdistan Region, Iraq (**Figure 1**) during January 2018. Naan bakeries used liquefied gas (NGB) with assisting firebricks for heating but Samoon furnaces used liquefied kerosene (OSF) or liquefied gas (GSF) as heating source. In the five (NGB1-5) places, dust residues and firebricks (FB) were collected as a sample. Dust residues and kerosene fuel sample in the six (OSF1-6) places were collected, while only dust residue sample was collected inside the four (GSF1-4) places. Three different samples of commercial kerosene from filling stations as reference kerosene (RK) and two samples of unused firebricks as reference firebrick (RFB) were collected and used to compare with other samples. During the period of sampling, thirteen of the bakers and Samoon furnaces owner did not allow sampling (NA1-13). Dusts residue sample was collected by using a clean brush, placed in clean plastic bags, labeled and kept from the laboratory till the analysis day.

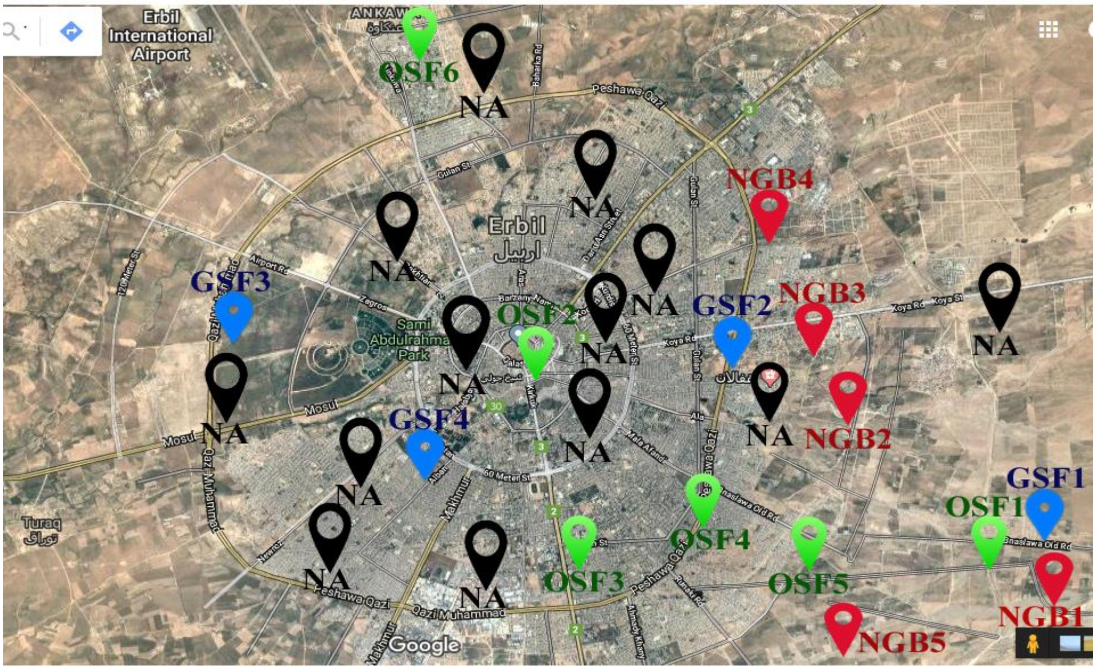

Figure 1: Study area and sampling location inside Erbil city center, NGB1-5; five Naan bakeries used liquefied gas, GSF1-4; four Samoon furnaces used liquefied gas, OSF1-6: Six Samoon furnaces used liquefied kerosene and NA1-13: thirteen places not allow sampling.

2.4. Sample Preparation and Digestion

Prior to analysis, a strong wet digestion method was applied to the residue dust and firebricks (FB) samples (Latif et al., 2014, Srithawirat and Latif, 2015). During sample digestion, 1.0 g of residue dust sample was treated and heated with 20 ml of a mixture of perchloric acid ($HClO_4$ 70%), hydrochloric acid (HCl 37%), and nitric acid (HNO_3 65%) with a volume ratio (1:1:2) to digest the sample completely. The digestion process was conducted in digestive Kjeldal's flask by using classic digestion-heater. Next, the solution was allowed to cool, filtrated, transferred and diluted with distilled water to 50 mL volumetric flask. The above steps were also applied to digest the collected FB samples.

For the kerosene digestion, combined suggested methods were applied with few modifications (Tekie et al., 2015). 10 mL of kerosene sample was added to the crucible and covered with a cap. Then, the sample was heated at 350℃ for about one hour using Box Furnace. Next, the temperature was increased until 450℃ for an extra one hour to destroy most of the organic material. After that, remained residue was quantitatively transferred to digestive Kjeldal's flask. Subsequently, 20 ml of the same acid mixture was used to complete digestion. Finally, the solution was transferred and diluted with distilled water to 50 ml volumetric flask. The above steps were repeated for blank and each type of the collected samples. Blank solution which contains only the digested acids or the reagents used to dissolve or digest the analyzed samples were individually prepared and repeated three times for each of the samples. Blank solution is mainly used for calibration purposes or zeroed the absorbance of all the other presented components in the sample solution except the component of interest.

2.5. Metal Analysis

During sample analysis, flame atomic absorption spectrometer (FAAS) was used to determine the level of chromium (Cr), cadmium (Cd), copper (Cu), and nickel (Ni) heavy metals in all the digestive samples. Optimum operating instrumental conditions were conducted based on the instruments guideline (Whiteside and Milner, 1984). Finally, the estimated level of each metal in each sample was calculated and presented as parts per million ($\mu g \cdot g^{-1}$ for solid samples) and ($\mu g \cdot mL^{-1}$ for liquid samples).

2.6. Country permissible limit for heavy metals in dust/soil

In the last decades, maximum permissible level for heavy metals in dust and soil environment have been regulated and announced by many countries based on many researches and the safety of human's health. List of the declared maximum permissible limits for metals content which are shown in **Table 1** were used to assess the recorded level of heavy metals in investigated samples.

2.7. Statistical analysis

The results of the study were subjected to statistical significance using both Microsoft Excel 2010 and GraphPad Prism 6 program software. One-sample t test was employed to assess comparison of levels mean of heavy metals to the maximum permissible limits. One-way ANOVA analysis was performed to examine the difference of heavy metal levels between studied samples. Significance level was set to 0.05. Results are shown in various tabulated form in tables and figures. This research was performed on fifteen collected samples from vary Naan bakeries and Samoon furnaces environment.

3. RESULTS AND DISCUSSIONS

All results data for the level of selected heavy metals including Cr, Cd, Cu, and Ni in the fifteen locally Naans bakery and Samoons furnace samples are presented in Figures 2, 3, and 4 in detail. According to results, the recorded percentage for observed metal (OM) from the entire of the investigated dust samples (n=15) were different and individually equal to 20%, 60%, 93.3%, and 100% for each of Cd, Cr, Ni, and Cu respectively. Thus, the percentage of OM value for Cu metal was the highest (100%) because copper metal was presented and detected in a whole ($\frac{15}{15} \times 100$) of the analyzed dust samples.

3.1. OSF Environment

In **Figure 2 (a)**, results data for the content of the selected metals are shown for the collected residue dust samples from the six OSF environments. The levels of Ni and Cu were recorded in a high amount and ranged from < d.l. µg·g^{-1} (OSF6) to 157.83 µg·g^{-1} (OSF2), and 38.463 µg·g^{-1} (OSF3) to 117.76 µg·g^{-1} (OSF4), respectively. Besides, the level of Cr metal was present only in the last three samples (OSF4-6) and ranged from 56.25 µg·g^{-1} to 66.66 µg·g^{-1}. The cadmium level for two of the samples was only present and equal to 0.2066 µg·g^{-1} (OSF1) and 1.2396 µg·g^{-1} (OSF4). Thus, the highest recorded heavy metals level was Ni in the OSF2 sample and was 157.83 µg·g^{-1}.

Results data in **Figure 2 (b)** show the content of the metals in kerosene samples from the six OSF places and RK from commercial filling stations. The kerosene fuel which is mainly used by OSF owners as main heating source was used for the metal analysis in order to know the source of heavy metals in the collected residue dust samples in OSF environment. In order to evaluate the levels of the targeted metals (Figure 2 (b)), the recorded data of RK was also compared with the data of kerosene fuel from OSF places. Thus, the levels of Cr and Cd in all of the collected OSF samples were present as below the detection limit. The concentration of the Cu metal was only detected in the first two samples including 5.769 µg·mL^{-1} (OSF1) and 3.245 µg·mL^{-1} (OSF2). However, the Ni concentration was not detectable in all of the collected kerosene samples except the OSF4 sample (2.83 µg·mL^{-1}).

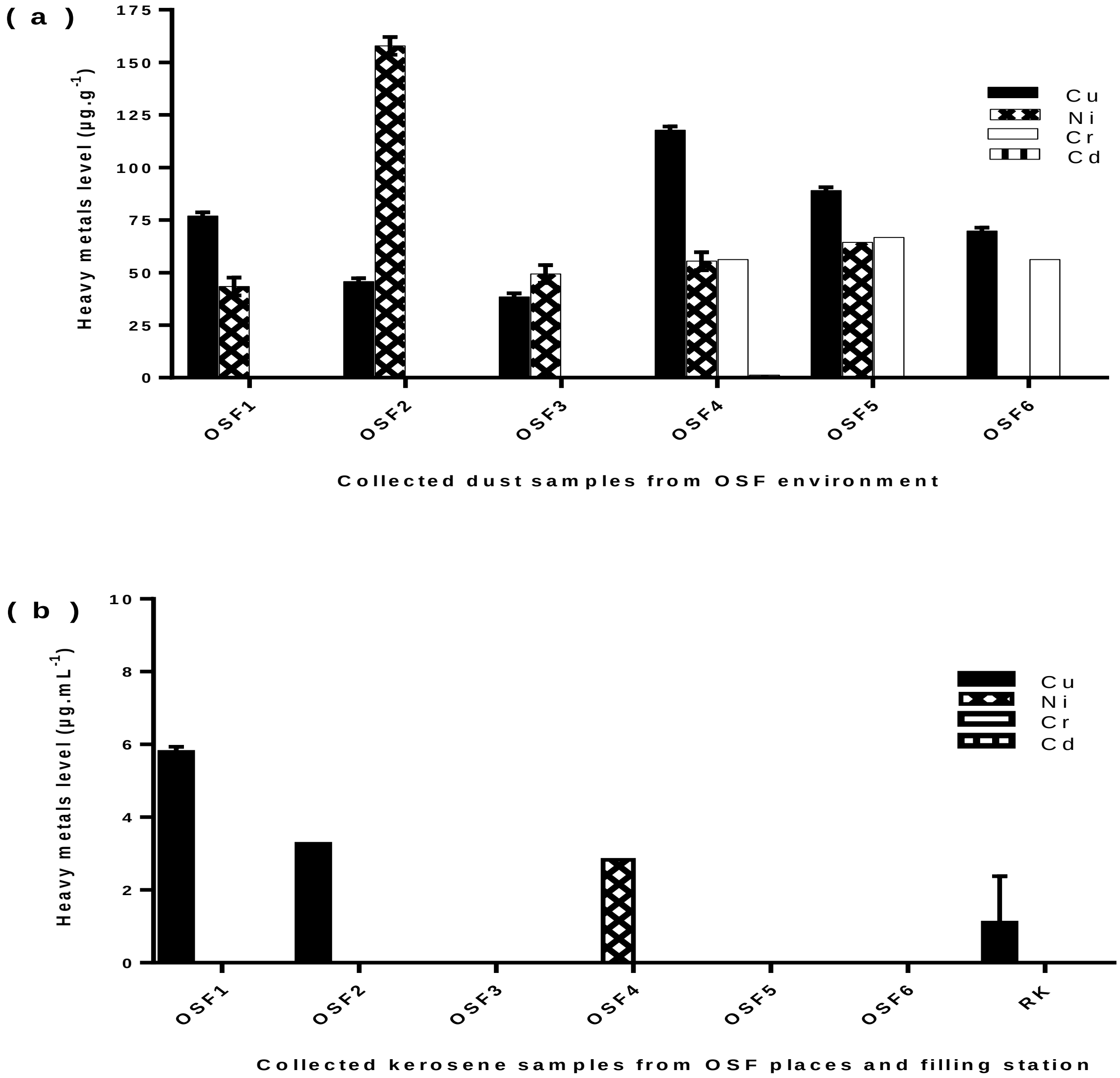

Figure 2: Shows the content of metals in collected (a) residue dust samples from six OSF environment, and (b) kerosene samples from the six OSF1-6 places compared with mean level of reference kerosene samples (RK) from filling station.

According to result in **Figure 2 (b),** the mean content of the selected metals in the RK sample is present as a below detectable excepting 1.08±1.29 $\mu g{\cdot}mL^{-1}$ for Cu metal. Due to comparing the level of the selected metals in **Figure 2 (b),** the samples of RK which given by filling stations can be seen as a purer than some kerosene samples collected from OSF places. In addition, the presence of the targeted metals in the collected residue dust samples of OSF places can come from the environment and preconcentration stepwise of residue dust of the kerosene fuel consumption.

3.2. GSF Environment

The investigated metals levels in the collected dust samples are shown in **Figure 3** for the four GSF places. The content of investigated metals in GSF samples were in the ranges of 58.89–91.35 $\mu g{\cdot}g^{-1}$ for Cu, 40.361–117.65 $\mu g{\cdot}g^{-1}$ for Ni, < d.l.–87.5 $\mu g{\cdot}g^{-1}$ for Cr and < d.l.–1.24 $\mu g{\cdot}g^{-1}$ for Cd, respectively.

The result data in **Figure 3** confirmed that the level of the selected metals in all the samples recorded in a high amount excepting Cd level was present as a minimum amount or below the detection limit. Thus, all of the GSF environments are contaminated and included a high present amount of these metals. The presence of the selected heavy metals in the collected residue dust samples of OSF places can come from the environment atmosphere and may come from preconcentration stepwise of residue dust of the used fuel consumption.

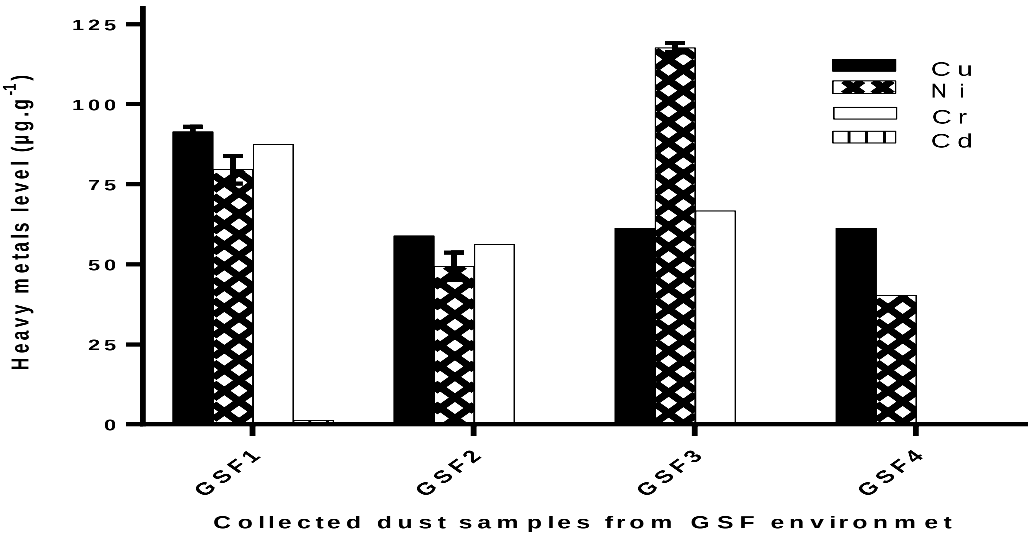

Figure 3: Shows the selected metals level in collected residue dust samples from GSF environment

3.3. NGB Environment

The determined level for the selected heavy metals is illustrated in **Figure 4** for the collected residue dust and firebrick (FB) samples from five NGB environments. Firebricks play an important role as assisted materials of heat/energy storage or in the waste heat recovery which have also been used with kerosene fuel by bakers in Erbil city. Results data on reference firebricks (RFB) were also used to compare with the collected firebrick samples from NGB places.

According to results data in **Figure 4 (a-b),** both Cu and Ni metals recorded at a high level in the entire collected samples of the NGB environment. The Cu and Ni levels range in the NGB samples are equal to (67.3 - 328.12 μg·g^{-1} in dust, 36.05 - 308.89 μg·g^{-1} in FB), and (67.465 - 166.86 μg·g^{-1} in dust, 61.442-209.04 μg·g^{-1} in FB), respectively. The content of investigated Cr metal in the dust and FB samples were in the range (<d.l. – 178.54 μg·g^{-1}) and (<d.l. – 619.96 μg·g^{-1}), respectively. Also, the highest Cr metal level recorded inside NGB4 (619.96 μg·g^{-1} in FB) environment. The level of Cd in all of the NGB samples exhibited below detection limit excepting FB sample from NGB1 including 0.2066 μg·g^{-1}.

The content of the investigated metals inside the RFB demonstrated at a minimum level or below the detection limit. However, a high amount of the selected heavy metals present in the collected FB in NGB samples. In NGB environment, the main sources of targeted heavy metals could come from the polluted atmosphere, fuel consumption and the decay of the FB components during heating.

Considering comparing all the above result data, the highest levels for the determined heavy metals in the residue dust environment recorded as follows concentration (μg·g^{-1}): NGB (328.12) > OSF (117.76) > GSF (91.35) for Cu, NGB (166.86) > GSF (117.65) > OSF (64.45) for Ni, NGB (178.54) > GSF (87.5) > OSF (66.66) for Cr, and GSF (1.24) > OSF (1.23) > NGB (<d.l.) for Cd. The highest amount of Cu, Ni, and Cr were recorded inside the NGB environment due to comparing with finding results from GSF and OSF places. It verifies that most of the bakeries' Naan environment contaminated with a high amount of these heavy metals because the recorded level for total selected metals load (TSML) in NGB environment (392.23 μg·g^{-1}) was approximately twice times higher than both OSF (207.45 μg·g^{-1}) and GSF (211.31 μg·g^{-1}) environment respectively (**Table 1**).

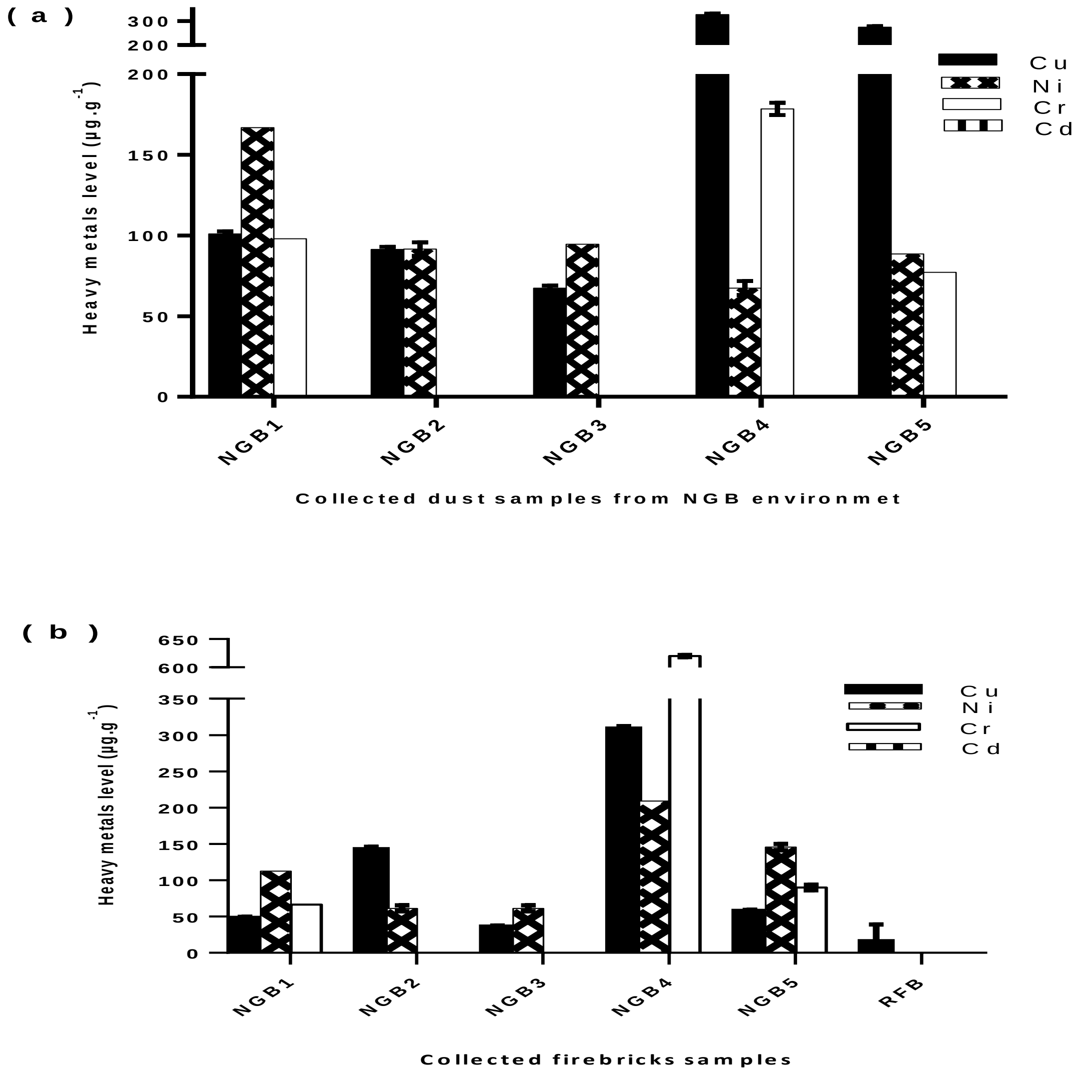

Figure 4: Shows the level of some heavy metals in collected (a) residue dust samples from five NGB environment, and (b) firebrick samples from five NGB environment compared with unused reference firebricks (RFB).

Collected residue dust for the most of the samples in this study included different amount of the investigated heavy metals. Summarized results in this study are shown and compared with different country standard allowable limitation guidelines for heavy metals in dust/soil in **Table 1** (Al-Fatlawi and Al-Alwani, 2012, ECDGE, 2004, Okedeyi et al., 2014, Sezgin et al., 2004, Fabis, 1987).

In the **Table 1**, Fabis (1987) allowable standard for heavy metals permission limit in dust was selected and used to evaluate finding results in this study. Of note, the means content of Cu and Ni in all investigated dust samples exceeded the permissible limit specified by Fabis (1987) (**Table 1**). However, mean concentration of cadmium (Cd) in all dust samples was lower than the selected permissible limit. Indeed, the mean concentrations of all elements in NGB environment were higher than selected maximum permissible limit excepting Cd metal. There was no significant difference between OSF, GSF, and NGB samples in terms of mean content of targeted heavy metals in dust (p= 0.43) due to performing One-way ANOVA analysis.

For the dust samples in NGB environment, only 20% of samples exceeded the permissible limit for Cr, while all samples (100%) significantly exceeded the permissible limit for Cu and Ni. In terms of the documented exceeding permissible limit for Cu and Ni metals, 66.66% and 50% in the dust OSF samples and 100% and 50% in the dust GSF samples were documented respectively. None Findings over permissible limit were presented in the entire (15) of the samples for Cd metal. In terms of mean content for Cr in dust samples, only NGB samples environment exceeded the permissible limit specified by Fabis (1987) with 20%.

Based on many recent studies, sources of metals accumulation in dust environment were mainly derived from industrial emissions including weathering and combusting of coal and fuel combustion from traffic activities (Cai and Li, 2019, Tang et al., 2017, Wan et al., 2016, Dalton et al., 2018). Thus, it can be seen that the accumulated residue dust from bakeries and furnaces environment contaminated with polluted metals ongoing to accumulation and pre-concentration stepwise of the polluted atmosphere, the decay of firebricks and fuel consumption. Thus, results in this study show that the environment of most bakeries and furnaces inside Erbil city can be seen as unsafe for baking and impure place for working and human health ongoing to including above permissible limits for heavy metals.

Table 1: shows heavy metals level ($\mu g \cdot g^{-1}$) in residue dust samples and country allowable guidelines for some metal limits in soil/dust

No.	**Sample code**			**Cu**	**Cd**	**Cr**	**Ni**	Total selected metals load (TSML) ($\mu g \cdot g^{-1}$)
1	**This study Iraq-Erbil City**	**(OSF1-6)**	Range ($\mu g \cdot g^{-1}$)	38.46 – 117.76	<d.l. – 1.23	<d.l. – 66.66	<d.l. – 157.83	207.45
			Mean ($\mu g \cdot g^{-1}$)	**72.92**	**0.723**	**59.7**	**74.09**	
			SD ($\mu g \cdot g^{-1}$)	29.10	0.73	6.0	47.45	
			%OM	100%	33.3%	50%	83.3	
			%EPL	66.66%	0.0%	0.0%	50%	
2		**(GSF1-4)**	Range ($\mu g \cdot g^{-1}$)	58.89 – 91.35	<d.l. – 1.24	<d.l. – 87.5	40.36 – 117.65	211.31
			Mean ($\mu g \cdot g^{-1}$)	**68.21***	**1.24**	**70.14**	**71.73**	
			SD ($\mu g \cdot g^{-1}$)	15.5	0.0	19.9	34.9	
			%OM	100%	25%	75%	100%	
			%EPL	100%	0.0%	0.0%	50%	
3		**(NGB1-5)**	Range ($\mu g \cdot g^{-1}$)	67.3 – 328.12	<d.l.	<d.l. – 178.54	<d.l. – 166.86	392.23
			Mean ($\mu g \cdot g^{-1}$)	**172.6***	**<d.l.**	**117.8**	**101.8***	
			SD ($\mu g \cdot g^{-1}$)	119.9	<d.l.	53.6	37.9	
			%OM	100%	0.0%	60%	100%	
			%EPL	100%	0.0%	20%	100%	

Permissible limit (PL) guidelines for dust/soil

No.	**World standard countries**	**Cu ($\mu g \cdot g^{-1}$)**	**Cd ($\mu g \cdot g^{-1}$)**	**Cr ($\mu g \cdot g^{-1}$)**	**Ni ($\mu g \cdot g^{-1}$)**	**References**
1	**Germany**	40.0	1.0	60.0	50.0	(Okedeyi et al., 2014) (ECDGE, 2004)
2	**Netherlands**	40.0	0.5	30.0	15.0	
3	**Sweden**	40.0	0.4	60.0	30.0	
4	**USA**	75.0	1.9	150.0	21.0	
5	**Ireland**	50.0	1.0	--	30.0	
6	**Fabis 1987**	**50**	**3**	**100**	**50**	(Sezgin et al., 2004) (Fabis, 1987, Al-Fatlawi and Al-Alwani, 2012)

%EPL: means the percentage of analyzed samples which were exceeding permissible limit (EPL) or above mentioned permissible limit for each metal, SD: Standard Deviation. <d.l: below detection limit. *: Significantly higher than maximum permissible limit, %OM: represents the percentage of observed or presented for each individual metal in the entire of sample, NGB1-5; five Naan bakeries used liquefied gas, GSF1-4; four Samoon furnaces used liquefied gas, OSF1-6: Six Samoon furnaces used liquefied kerosene. TSML: represents the summation calculation of the means level of all selected metals (Cu, Cd, Cr, and Ni) for each of the analyzed sample, n; number of collected samples.

4. CONCLUSIONS

According to result data, most of the collected dust samples inside the bakeries and furnaces environment in Erbil city included a high amount of the investigated heavy metals and exceeded standard permissible limits. The polluted atmosphere, fuel consumption and firebricks decay during heating can be selected as main sources for metals contamination due to pre-concentration and accumulation process of dust residue. The recorded metals content in most bakeries and furnaces environment were higher than most country guidelines for standard allowable metals in soil and dust environment. The assessment comparison of results proved that the environment of bakeries' Naan is unsafe for baking or working and more contaminated than Samoon furnaces environment.

5. RECOMMENDATION

Results data show that more attention should be paid to heavy metal contamination of the foods environment in the future because of their high toxicity potential, widespread use, and prevalence. It is recommended that the government should prevent the use of low quality kerosene consumption as heating sources by the local bakery and furnace owner. Additionally, bakery and furnace owners must clean their entire working area daily from accumulated residue dust especially inside the heating environment chamber due to more attention to health safety.

ACKNOWLEDGMENT

I would like deeply thank to Naan's bakery and Samoon's furnace owner who allowed us for the sampling during this research project.

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