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Indoor Air Concentrations of Heavy Metals in Two Shisha Smoke Cafés in Baghdad

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Abstract

Shisha smoke represents one of the causes of indoor air pollution. Heavy metals represent the main components in shisha smoke. In this research study, the indoor concentrations of heavy metals in shisha smoke café sites was investigated, samples were taken from two café sites (site1, site 2) which differ in their volume. Site1 volume was 77m^3, while site 2 was 437.5m^3. Sample were taken by using a low volume sampler (sniffer), and then examined by the Atomic Absorption Spectrometry (AAS). The results showed that indoor air shisha smoke samples for both experimental sites have shown a significant amount of heavy metals as compared with control sampling values. The mean concentration values of (Pb, Zn, Co, Ni, Cr) in site 1 were (11.004, 9.544, 24.088, 19.84, 24.98 µg/m^3) respectively, while the mean concentration values of these heavy metal in site 2 were (5.574, 6.578, 16.684, 26.114, 9.636 µg/m^3) respectively. Results and conclusions referred those indoor air concentrations during shisha smoking times were high and exceed the WHO standard limits.

Keywords: Heavy metals, Shisha smoke, Indoor air cafes.

تراكيز المعادن الثقيله للهواء الداخلي في مقهيين لتدخين الشيشه في بغداد

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الخلاصة:

يعد دخان الشيشه احد مسببات تلوث الهواء الداخلي ، وتمثل المعادن الثقيله احدى اهم مكونات دخان الشيشه . تم التحري في هذه الدراسه البحثيه عن تراكيز المعادن الثقيله للهواء الداخلي في مقهيين (موقع 1،موقع 2) واللذان يختلفان في حجم الصاله الداخليه ،كان الحجم الداخلي لصاله المقهى الاول 77م^3 وكان الحجم الداخلي لصاله المقهى الثاني 437,5 م^3. تم استخدام جهاز اخذ نماذج الهواء قليله الحجم (sniffer) ثم تم فحص النماذج باستخدام جهاز التحليل الطيفي للامتصاص الذري (AAS) . اشارت النتائج الى ان نماذج دخان الشيشه في كلا الموقعيين سجلت زياده معنويه في تراكيز المعادن الثقيله مقارنه بقيم نماذج السيطره ، وكانت معدلات تراكيز العناصر (Pb, Zn, Co, Ni, Cr) للموقع الاول كانت (11.004, 9.544, 24.088, 19.84, 24.98 µg/m^3)على التوالي ، بينما كانت معدلات التراكيز لتلك العناصر في الموقع الثاني (5.574, 6.578, 16.684, 26.114, 9.636 µg/m^3) على التوالي. ان هذه النتائج تشير بشكل

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واضح الى ان الهواء الداخلي لصالات المقاهي خلال اوقات اشغالها من قبل مدخني الشيشه يمتلك تراكيز عاليه للمعادن الثقيله ، وان هذه التراكيز تفوق التراكيز القياسيه المحدده من قبل منظمه الصحه العالميه.

Introduction

Shisha smoking represents a public health threat. This habit wide spreads lately among youth community in Baghdad. Shisha smoke pulled through water before it received by smoker, this made some people to believe that shisha is less harmful than cigarette smoking [1].

Shisha smoke is similar to that of cigarettes. Shisha smoke that may have significant amounts of dangerous substances, including heavy metals such as arsenic, cobalt, chromium, and lead [2].

Heavy metals are trace metals that are at least five times denser than water and are taken into body via inhalation, ingestion and skin absorption. Heavy metals are among the many substances contained in tobacco smoke. Although metals can be deposited on tobacco leaves from particles in the air and some fungicides and pesticides containing toxic metals that had been sprayed on tobacco leaves or soils via growing time, most of the metals present in plants are absorbed from the soil. Soils, therefore, including any amendments to the soil, such as sludge, fertilizers, or irrigation with polluted water have been the predominant source of metals found in tobacco grown in various geographic areas have also suggested that consideration of soil pH is important to understanding the relationship between metals in the soil and metals in the tobacco leaf. Most heavy metals are not volatile at room temperature. The temperature of tobacco that burns is important also to volatilize many metals into the gas phase, but by the time the smoke is inhaled or rises in a plume as secondhand smoke and most of the metals have condensed and moved into the particulate portion of the smoke aerosol [3].

Indeed, in Saudi Arabia, researchers determined by atomic absorption that out of 14.685 mg heavy metals present in 1 g of the moassel paste, only 3.075 µg were transferred to the smoker. In India, an association was found between tobacco smoking habits of male and female rural subjects using hookah and increased Cd levels in hair and nails [4].

Shihadeh, (2003) [5] found that, Significant amounts of heavy metals were determined in the mainstream of shisha smoke With a smoking protocol of 100 puffs of 3 s duration spaced at 30-s intervals, high levels of arsenic, chromium and lead were obtained in a single smoking session and the cellulose filters were analyzed for 12 key metals (cobalt, arsenic, boron, cadmium, chromium, copper, mercury, nickel, lead, selenium, vanadium, zinc).

As shown, the levels of chromium, cobalt and lead are orders of magnitude greater than produced by a single cigarette. Arsenic, beryllium and chromium are listed by IARC as Group 1(known human) carcinogens, while cobalt and lead are listed as Group 2B (possible human) carcinogens Nickel, depending on its form, appears on both the Group 1and Group 2B lists [6].

Tobacco smoke may contain arsenic, especially when the tobacco plants have been treated with lead arsenate insecticide. Although the use of arsenic pesticides is now prohibited in most countries [7].

It is estimated that the arsenic content of mainstream cigarette smoke is in the range of 40–120 ng per cigarette. If consumption is 20 cigarettes per day, the daily intake from this source would form 0.8–2.4 µg [8].

Materials and methods

Study locations

The field study was conducted at 2 busy closed café where each of them located in Baghdad /Palestine street .The first one has an estimated capacity of 50 person and its crowded by youth most of them are university students, age vary between 20-29 years old. The dimensions of smoking room in this café are (10m x3.5m x2.2m) with moderate ventilation. Smokers inside the café lobby were 8 shisha smokers and seven cigarettes in average during sampling period.The capacity of second café is approximately six times larger than the first one , its dimensions are (17.5m x10m x2.5m) with well ventilation, the ages of visitors range between 18-35 years . Shisha smoker's numbers were 30, while cigarette smokers were 10 in average during sampling period. Each cafes offers shisha of various tobacco flavors (common moassel) Control readings have been taken for both café rooms before get occupied by smokers.

Air samples were collected on cellulose filters by using low volume sampler (Sniffer air vacuum sampler) instrument (radeCo, Inc.US origin). Before sampling, cellulose filters were dried in oven for 15 minutes at 80Cº and weighted to record initial weight (W1) by using an accurate balance, and then filter was kept inside container until used in sampling location. In study location, the filter was placed in the sampler device, which is placed on a table inside the café hall about 1m above the floor level and 1- m away from the shisha smoker's [9]. Eight samples (5samples from10am-3pm and other 3 samples from 5pm -8pm) have been taken from each location. The duration of each sample is 60 min.During the sampling operation, the volume of air was recorded at the beginning of sampling (V_1) and at the end of sampling (V_2) which is used later to calculate the total volume of air at time (Vt) .At the end of sampling operation, the exposed filter removed from the sampler and kept inside container until weighted in laboratory again, this weight represent final weight (W2).

Determination of heavy metals concentrations.

Step -1: Digestion method of air filters samples:

The digestion method represents the dissolving of filter solid sample with acids in order to transform the sample to the liquid state, which is able to be measured by atomic absorption spectrometer.

This procedure represents the following [10]:

1- Air filter sample was cut into small pieces and put in a Teflon beaker.
2- (5 ml) of (HNO_3) acid were added to the shredded sample.
3 - Drying the samples by using a heater.
4 - Dry samples left to cool after heating.
5- (3 ml) of ($HClO_4$) acid were adding to each cooled sample and re-heat it again.
6-Sample removed from heat before drying and left to get cold.
7- (2 ml) of (HF) acid added to each sample then covered, and left for 24 hours to let the solution get clear.
8 - Each sample was filtered by using a volumetric flask of 50 ml size.
9 - Each sample volume was completed with a de-ionized water to 50 ml. Samples preserved in plastic containers to be ready for the atomic absorption spectrometry examination.

The blank solution represents the digestion acids with a certain concentration under the same conditions of samples during the analysis. Acids used in samples digestion are: nitric acid (sigma Aldrich co.), perchloric acid (Thomas Baker) and hydrofluoric acid (Loba chemie).

The measurements calculated by using the following equation [10].

Metal Conc. (µg/m3) = C *Vi / VT

Where: C is the concentration of the element in the sample in (ppm).
Vi: Sample volume in (ml).
VT: Total volume of drawn air in (m^3).

Step -2:Atomic Absorption Spectrometry (AAS) Examination:

The concentrations of the heavy metals in sample solution were determined by using (AAS). Briefly, this device works to heat the samples to (2000 C°), by using Acetylene gas flame in order to transform the sample from the liquid to the vapor statue to allow the (AAS) device to measure the element concentrations for each sample. The (AAS) device specifications are: (AA-6200) model, US made and available in the laboratories of Environmental Research Center of the Ministry of Science and Technology.

Statistical Analysis

All data were expressed as mean ± SD, The calculations were performed by SPSS program version 17 Difference between sites were compared by Student's *t*-test with $P<0.05$ selected as the level of statistical significance**.**

Results and discussion

Heavy metals concentrations

Table 1 contains mean value ± standard deviation of heavy metals that examined in ambient air of two randomly selected café sites and control site that has not experience cigarette or shisha smoke

Table 1-Mean value ± SD of Pb, Zn, Co, Ni, Cr and Cu measured in ambient air of examined two coffee shops and control.

Heavy metals		Mean ± SD		
		Site 1	Site 2	Control
Pb	µg/m³	11.004±2.39	5.574±2.396	1.02±0.42
Zn		9.544±0.311	6.578±1.49	0.5±0.08
Co		24.088±0.571	16.684±2.118	0.05±0.01
Ni		19.84±11.236	26.114±6.958	0.12±0.07
Cr		24.98±15.565	9.636±2.8	0.1±0.02
Cu		n.d.	n.d.	n.d.

In previous studies, High levels were obtained in a single shisha smoking session. Arsenic, chromium, nickel, lead were records 0.165, 1.34, 0.99, 6.87 µg/session respectively .these levels represents significant amounts in the mainstream of shisha smoke [5]**.** Also 1 g of the moassel paste contains of 14.685 mg (heavy) metals present, only 3.075 µg were transferred to the smoker **[**4].

The results of current study agreed with previous studies and showed that shisha smoke samples obtained from indoor air of both experimental sites records significant amount of heavy metals. The highest lead (Pb) mean value was 11.004±2.39 µg/m³ in site 1 and lowest mean value was 1.02±0.42 µg/m³ in control site while site 2 had a mean value of 5.574±2.396 µg/m³; figure 1. The mean values of lead (Pb) in both sites were exceeded the national standard (1.5 µg/m³ (1 year), 2 µg/m³ (24 hour)) and world limits (0.5 -1 µg/m³ (1 year)).

Most of the metals present in tobacco plants are absorbed from the soil because of fertilizers, or irrigation with polluted water and can be deposited on tobacco leaves from particles in the air [1].

The tobacco plant absorbs lead from the soil and around 5-6% of that in cigarettes is inhaled in the smoke. Lead concentrations in the smoke from one cigarette were found to range from 0.017 to 0.98 µg [11].

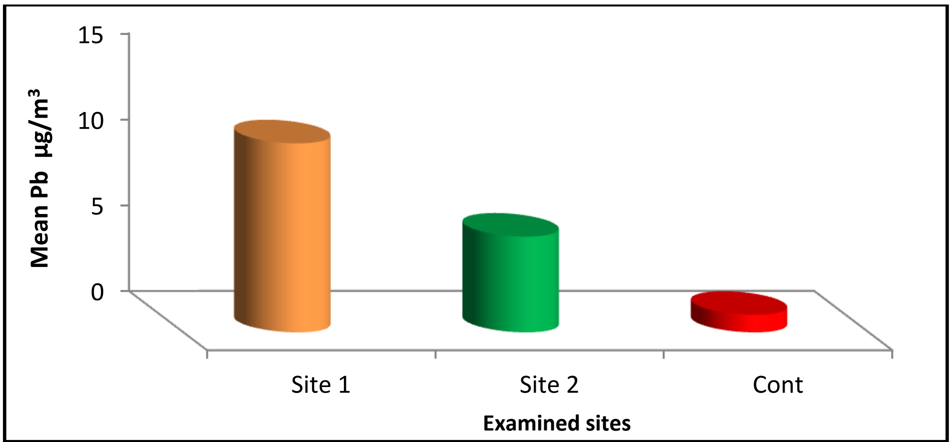

Figure 1-Mean Pb (µg/m³) measured in examined sites during this study.

The differences between these data using t test were significant where it was at P ≤0.05 between site 1 Vs site 2, site 1 Vs control and site 2 Vs control were P≤0.001 and P≤0.01 respectively table 2.

In case of zinc ambient air, similar pattern of Pb was found where highest mean value (9.544±0.311 µg/m³) was recorded in site 1 and the lowest mean value (0.5±0.08 µg/m³) was in control site while site 2 shows a mean value of 6.578±1.49 µg/m³ , Figure 2. Zinc is present in tobacco and absorbed from soil treatments with fertilizers (average 24 mg/g) and about 70% is transferred to the smoke [12].

WHO refers that the world standard of Zn ranged between (0.1-1 µg/m³) in current study Zn mean values in both experimental sites exceeded WHO limits.

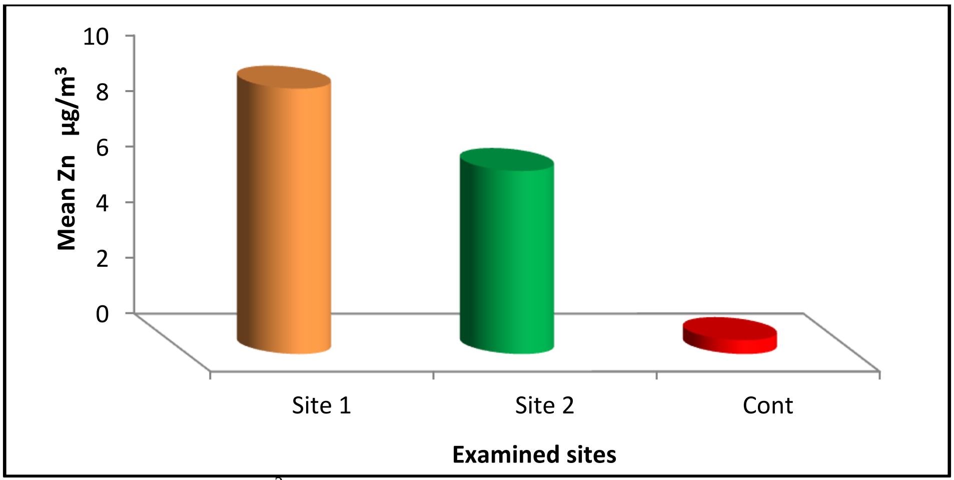

Figure 2-Mean Zn (µg/m^3) measured in examined sites during this study.

However, t test shows significant differences between these data at P≤0.001 between all examined sites table 2.

Table 2-The differences between Site1 and Site2 data using t test

Heavy metals	t test					
	Site1 vs Site2		Site1 vs Control		Site2 vs Control	
	t value	Prob.	t value	Prob.	t value	Prob.
Pb	2.763	0.05	9.166	0.001	4.576	0.01
Zn	5.498	0.001	79.333	0.001	11.521	0.001
Co	4.353	0.01	94.537	0.001	22.213	0.001
Ni	1.341	ns	4.962	0.01	10.503	0.001
Cr	2.744	0.05	4.521	0.01	9.633	0.001

Regarding ambient air Co content, highest mean value (24.088±0.571 µg/m³) was found in site 1 while the lowest mean value (0.05±0.01 µg/m³) was recorded in control site and the site 2 had a mean value of 16.684±2.118 µg/m³ , figure 3.

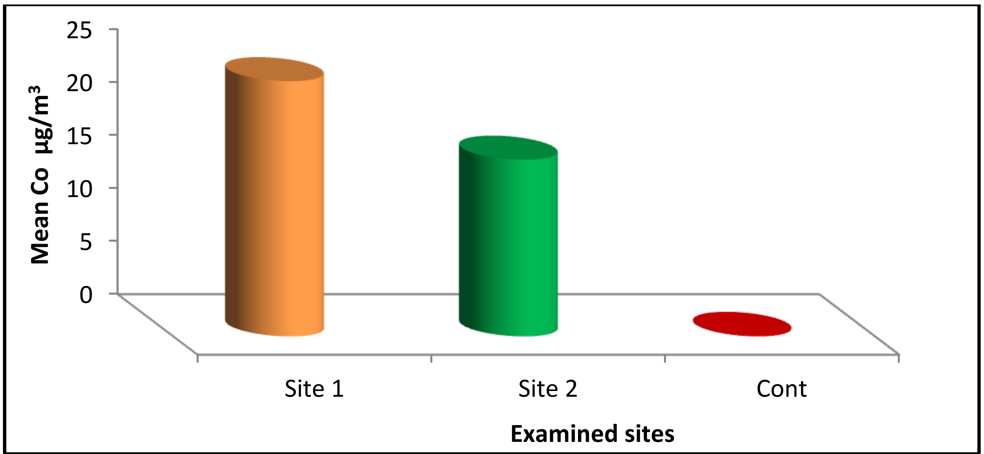

Figure 3-Mean Co (µg/m^3) measured in examined sites during this study.

The differences between mean of these data by using t test were significant at P≤0.01 between site 1 vs. site 2 while at P≤0.001 between site 1Vs control and site 2 vs. control table 2.

A previous study record that inhalation risk values of cobalt was 0.5µg/m³ in tobacco smoke. This value caused effects on respiratory function [13]. The current study indicated that concentrations of cobalt in both experimental sites represents high value might be due to high levels of tobacco smoke released from cigarette smokers as well as shisha smokers whom occupied these sites. In case of ambient air nickel (Ni) content, site 2 had the highest mean value (26.114±6.958 μg/m³) While site 1 shows a mean value of 19.84±11.236 μg/m³ and the control site had the lowest (0.12±0.07 μg/m³) mean value, figure 4.

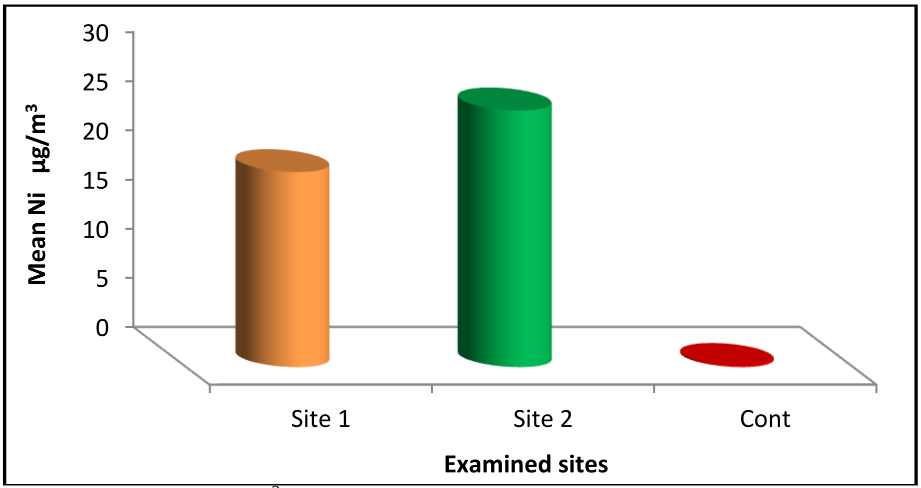

Figure 4-Mean Ni (μg/m^3) measured in examined sites during this study.

The differences, however between site 1Vs site were insignificant (P>0.05) by using t test while the differences between other comparisons (site 1Vs control and site 2 Vs control) were significant at P≤0.01 and P≤0.001 respectively table 2.

The high levels of nickel in current study may be because of up to 20% of the nickel in the tobacco is transferred to mainstream smoke during smoking. This high transfer rate, compared to the much lower transfer rates of other metals, has been explained by the formation of the volatile nickel carbonyl [14]. The International Agency for Research on Cancer (IARC) has recently defined nickel as a Group 1 "carcinogenic to humans" [15]. Nickel in tobacco smoke caused lung fibrosis [13].

Regarding chromium ambient air content, site 1 had the highest mean value (24.98±15.565 μg/m³) and site 2 shows a mean value of 9.636±2.8 μg/m³ while control site gave the lowest (0.1±0.02 μg/m³) mean value (Fig 5).the mean values of chromium in indoor air of both experimental sites refers to high values as compared with World Health Organization (WHO) standard (0.1 μg/m³).

Examining the differences between these data by t test had revealed significant differences but at various probabilities and were P≤0.05, P≤0.01 and P≤0.001 between site 1vs site2, site1vs control and site 2 Vs control respectively table 2.

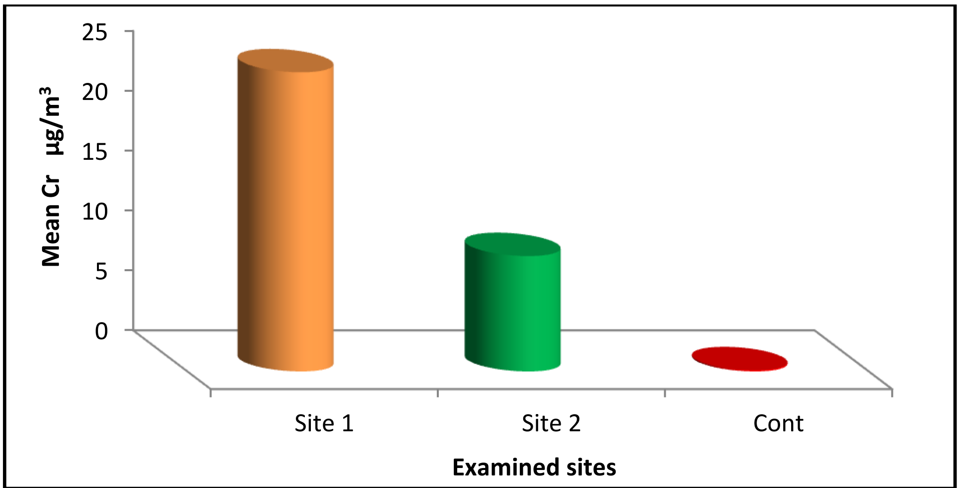

Figure 5-Mean Cr (μg/m^3) measured in examined sites during this study.

Tobacco smoke contains chromium (VI) and indoor air polluted by cigarette smoke may contain hundreds of times the amount of chromium (VI) found in outdoor air. Chromium is respiratory tract sensitizers and would cause asthma. Hexavalent chromium has been associated with lung cancer in both experimental animals and in epidemiological studies [14].

For copper ambient air content, the current study has failed to detect any concentration in all examined sites. Previous study measured the toxic and potentially carcinogenic elements such as lead, arsenic Indoor air contamination during a waterpipe (narghile) smoking session and they found a significant increase in their concentrations. Lead concentration was 11.2 ng/m3, while arsenic concentration 0.35 ng/m3 [9].

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