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Research paper

Concentrations and health risks assessment of heavy metals in cigarettes within Baghdad city

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Abstract

The risks associated with smoking can be due to the inhalation of toxic substances like heavy metals and polycyclic aromatic hydrocarbons (PAHs) that can be released during tobacco burns. In the present study we measured lead Pb and three other metals (cadmium Cd; Chrome Cr; and Zinc Zn) by flame atomic absorption spectroscopy (FAAS). In a twenty-five brands of cigarettes, assessing potential related health risks estimated intakes of these metals. The Related Cancer Risk (RCR) and Average Daily Intake (ADI) were calculated. The results revealed that the average values of Pb, Cd, Cr and Zn concentrations were (4.56, 0.39, 3.31 and 1.36) µg/g respectively. The total value of these four metals is greater than the range of cancer risk specified by USEPA.

Keywords: *Use about five key words or phrases in alphabetical order, Separated by Semicolon*

1. Introduction

Smoking kills one person among ten around the world [1]. There are about 1.1 billion smokers; their proportion varies between women and men. Generally, the ratio is distributed between 30% for women and 70% for men [2]. Tobacco contains more than 6000 toxic compounds which are released during the smoking process and they cause significant risks for a variety of respiratory and cardiovascular diseases and developing cancers. These compounds include heavy metals such as lead, cadmium, copper, arsenic and nickel besides polycyclic aromatic hydrocarbons (PAHs) like Benzo[a]pyrene that are characterized as strong carcinogenic for humans [3].

Exposing metals due to smoking of a single cigarette can be trivial and likely not severely toxic, but the accumulated of the inhaled amount of metals in the body during long period of time (months, years and decades) of exposure depends on clearance rates and health concern [4 and 5] Many heavy metals like Cd, Ni, Pb and Cr can accumulate in organ tissues after smoking [6-9], especially for Cd and Pb which have long half-lives between 10 to 12 year in the human body. Cigarette smoking can be considered the main exposure access for Cd and to a lower range Pb in the general population [8 and 9].

Lead (Pb) and cadmium (Cd) have unknown biological functions in humans, and have toxicity even at low concentrations. Furthermore, Pb and Cd are known as pollutants, while Cd and Cr are classified as carcinogenic and causes multiple disorders such as cardiovascular diseases, liver diseases, neurotoxic, and nephrotoxic making Cd and Cr a global concern [10].

In this study which was carried out in January-2019, in the Environmental Research Center, University of Technology, Baghdad, Iraq, twenty four brands of imported cigarettes from seven different origins and one local brand (USA, UK, Korea, Turkey, France, Switzerland and Iraq) were collected randomly from the markets in order to determine heavy metals concentration utilizing flame atomic absorption spectroscopy (FAAS). The investigated heavy metals were (lead (Pb), Cadmium (Cd), Chrome (Cr) and Zinc (Zn) and assess the human health risk through chronic consumption of tobacco

2. Materials and methods

2.1. Sample preparation and heavy metals analyses

The contents of each pack were emptied in the laboratory by removing cigarette papers and filters. Then tobacco samples were pulverized by ceramic mortar. 5 gm of tobacco powder of each brand sample was added to25 mL of concentrated HNO3, then mixed well and put on a hot plate and left to dry [11]. The remainder of the mixture was filtered through 0.45 Millipore filter paper and completes the volume to 10 ml using a volumetric flask with deionized water. Then the heavy metals concentration was analyzed using flame atomic absorption spectrophotometer (FAAS).

2.2. Assessment of lifetime cancer risk

Cancer power factors (CPF) ((mg/kg body-weight/day) −1) for the toxic heavy metals (Pb, Cd, Cr, and Zn) were calculated for both ingestion and inhalation processes of the tobacco consumption on a long-term basis. Lifetime cancer risk (LCR) due to tobacco products was determined by using equation number (1) [12].

$$\mathrm{LCR} = \mathrm{MDE} \times \frac{\text{Years of consumption.}}{\text{Mean lifetime}} \times \mathrm{CPF}$$

Where (MDE) is the mean daily exposure (mg/kg body-weight/day) which was calculated assuming the daily consumption of 10 gm of tobacco by a person with a body weight of 57.7 kg for 30 years out of an average lifetime of 70 years.

3. Results and discussion

Figures (1-4) summarized the concentrations of Pb, Cd, Cr, and Zn for the tobacco brands. lead values ranged from (1.235-9.260) µg/g with an average value of 4.563 µg/g. C19 recorded the highest concentration value of Pb while C11 recorded lowest concentration value with significant differences at ($p \leq 0.05$) as shown in Figure 1. Figure 2 illustrates the concentrations of Cd which were ranged from the lowest value of ND in C1 and C20 samples to the highest value of (1.559) µg/g in C15 with an average value of 0.3986 µg/g with significant differences at ($p \leq 0.05$). Figure 3 shows the concentration of Cd element, the values of Cd in study samples were ranged from ND value found in C5, C7 and C13 samples while the highest value of Cr concentration was found in C23 sample with value of (6.725) µg/g, and the average value was (3.31) µg/g, with significant differences at ($p \leq 0.05$). Finally, Figure 4 shows the concentrations of Zn which were ranged from (0.167- 3.112) µg/g with average 1.369 µg/g, Zn recorded highest level in C21 Sample while the lowest level was in C17 Sample, with significant differences at ($p \leq 0.05$). Sample C20 was found to contain the highest total amount of heavy metals with the value of (18.937) µg/g while C13 recorded the lowest total content of heavy metals with the value of (4.821) µg/g. The concentrations of the heavy metals varied considerably among different brands. Actually, the differences in heavy metal content could possibly be related to soil type, water contents of trace elements, growth conditions, and tobacco type and tobacco treatment process.
Comparison of the presents results obtained in this study with previous studies is shown in Table (1) the results are found to be comparable with others results.

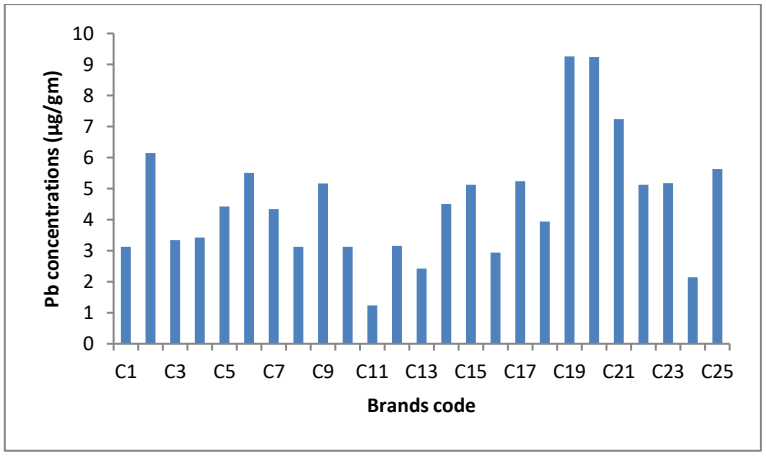

Fig. 1: Pb Concentrations in Tobacco Samples.

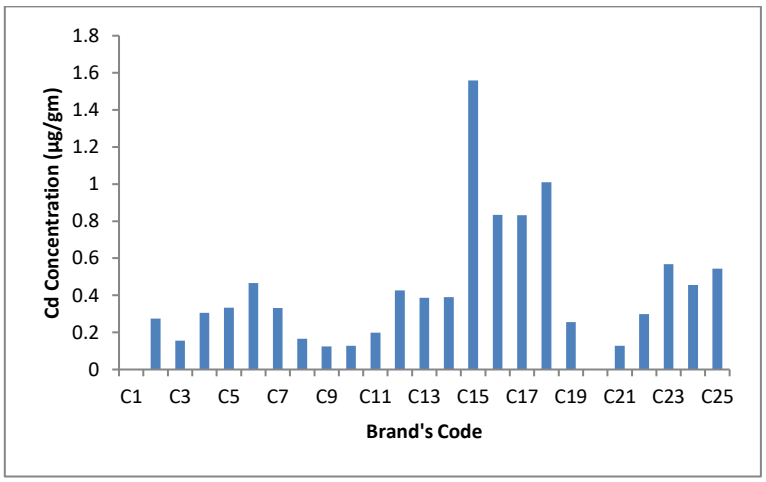

Fig. 2: Cd Concentrations in Tobacco Samples.

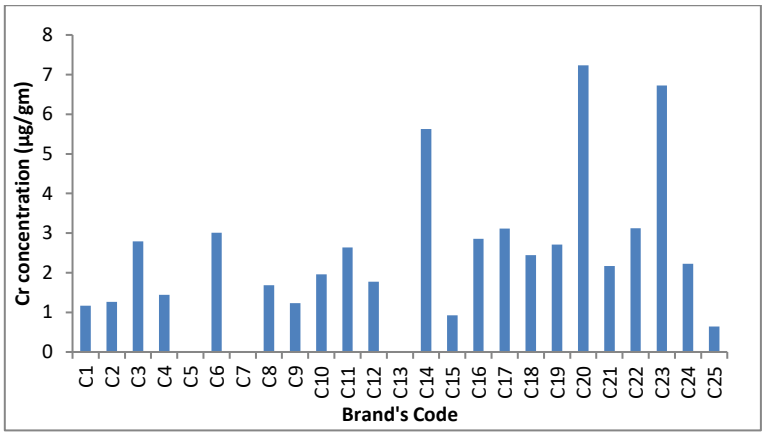

Fig. 3: Cr Concentrations in Tobacco Samples.

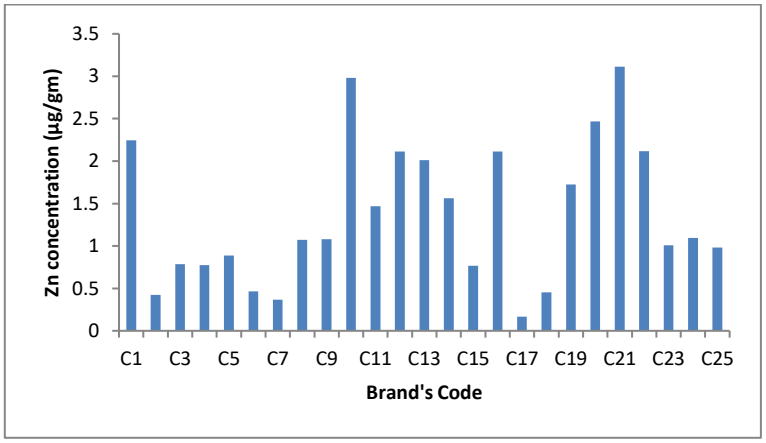

Fig. 4: Zn Concentrations in Tobacco Samples.

Table 1: Heavy Metal Concentrations (Mg/G) in Tobacco Cigarettes Compared with Previous Studies

Pb	Cd	Cr	Zn	Ref.
1.33-3.61	0.78-2.78	------	------	[13]
1.07-2.54, 1.77	0.91-3.46, 2.01	1.08-6.75, 2.26	------	[12]
7.50-32.50	1.82-5.40	------	------	[14]
0.6-2.00, 2.40	0.5-3.5, 1.70	0.1-3.45	16.8-30.5	[15]
0.44	0.86	2.35	-------	[16]
1.24-9.26, 4.56	ND-1.56, 0.40	ND-6.73, 3.32	0.17-3.11, 1.37	Present work

ND = Not detected

Table 2: CPF Values ((Mg/Kg Body-Weight/Day)$^{-1}$) As Described by California Environmental Protection Agency (CEPA 2009)

Pb	Cd	Cr	Zn
8.3×10^{-3}	15	0.42	0.2

The method of estimating potential toxicity assumes that 100% of the toxicant is potentially bio-available in ideal conditions and can fully contribute to the overall risk of the product [17-20]. In this study, 57.7 kg body weight was considered as the body weight of an Asian adult [21] and daily tobacco consumption data was collected from the report on Global adult tobacco survey by [22]. The toxicological risk calculated as a cancer risk for Pb, Cd, Cr, and Zn at a transfer rate of 100% are presented in Table (3). The risk of individual metal for the study samples ranges from 9.96×10-6 to 1.05×10-6 for Pb, from 9.25×10-4 to 1.11 ×10-3 for Cd, from ND to 1.13×10-3 for Cr, and from 8.14×10-5 to 2.31×10-4 for Zn. The total value of these four metals is greater than the range of cancer risk compared with the limit value of 10×10-4 to 10×10-6 specified by [23].

Table 3: Lifetime Cancer Risk of the Tobacco Consumption on A Long-Term Basis

Brand's Code	Pb	Cd	Cr	Zn	Total value
C1	9.86×10^{-6}	ND	1.82×10^{-4}	1.67×10^{-4}	3.59×10^{-4}
C2	1.94×10^{-5}	1.53×10^{-3}	1.98×10^{-4}	3.14×10^{-5}	17.75×10^{-4}
C3	1.05×10^{-5}	8.63×10^{-4}	4.35×10^{-4}	5.84×10^{-5}	13.67×10^{-4}
C4	1.08×10^{-5}	1.71×10^{-3}	2.25×10^{-4}	5.76×10^{-5}	19.98×10^{-4}
C5	1.40×10^{-5}	1.86×10^{-3}	ND	6.59×10^{-5}	19.4×10^{-4}
C6	1.74×10^{-5}	2.60×10^{-3}	4.70×10^{-4}	3.45×10^{-5}	31.18×10^{-4}
C7	1.37×10^{-5}	1.85×10^{-3}	ND	2.73×10^{-5}	18.9×10^{-4}
C8	9.86×10^{-6}	9.25×10^{-4}	2.63×10^{-4}	7.97×10^{-5}	12.77×10^{-4}
C9	1.63×10^{-5}	6.96×10^{-4}	1.92×10^{-4}	8.01×10^{-5}	9.85×10^{-4}
C10	9.85×10^{-6}	7.13×10^{-4}	3.05×10^{-4}	2.21×10^{-4}	12.49×10^{-4}
C11	3.90×10^{-6}	1.11×10^{-3}	4.11×10^{-4}	1.09×10^{-4}	16.32×10^{-4}
C12	9.96×10^{-6}	2.37×10^{-3}	2.77×10^{-4}	1.57×10^{-4}	28.17×10^{-4}
C13	7.65×10^{-6}	2.16×10^{-3}	ND	1.49×10^{-4}	23.13×10^{-4}
C14	1.42×10^{-5}	2.18×10^{-3}	8.78×10^{-4}	1.16×10^{-4}	31.87×10^{-4}

C15	1.62×10^{-5}	8.69×10^{-3}	1.44×10^{-4}	5.70×10^{-5}	89.02×10^{-4}
C16	9.26×10^{-6}	4.64×10^{-3}	4.45×10^{-4}	1.57×10^{-4}	52.52×10^{-4}
C17	1.65×10^{-5}	4.64×10^{-3}	4.89×10^{-4}	1.24×10^{-5}	51.50×10^{-4}
C18	1.24×10^{-5}	5.63×10^{-3}	3.81×10^{-4}	3.38×10^{-5}	60.54×10^{-4}
C19	2.92×10^{-5}	1.43×10^{-3}	4.23×10^{-4}	1.28×10^{-4}	20.06×10^{-4}
C20	2.92×10^{-5}	ND	1.13×10^{-3}	1.83×10^{-4}	13.41×10^{-4}
C21	2.28×10^{-5}	7.13×10^{-4}	3.38×10^{-4}	2.31×10^{-4}	13.05×10^{-4}
C22	1.62×10^{-5}	1.66×10^{-3}	4.87×10^{-4}	1.57×10^{-4}	23.21×10^{-4}
C23	1.63×10^{-5}	3.16×10^{-3}	1.05×10^{-3}	7.49×10^{-5}	43.04×10^{-4}
C24	6.77×10^{-6}	2.54×10^{-3}	3.48×10^{-4}	8.14×10^{-5}	29.76×10^{-4}
C25	1.78×10^{-5}	3.03×10^{-3}	1.01×10^{-4}	7.29×10^{-5}	32.16×10^{-4}

ND = Not detected.

4. Conclusions

Smoking of cigarettes may be concerned as an essential cause of inhalation of the highly toxic elements not only to the smoker but also, through passive smoking, to nonsmokers. They also have a reverse health effects on the fetus through maternal smoking, and on infants through parental smoking.

The results of this study provide an overview of four heavy metal concentrations (Pb, Cd, Cr , and Zn) measured in tobacco products. From the results, we concluded that all tobacco products contain a high level of the four measured heavy metals. The cancer risk, which is based on the consumer's practice, bodyweight, lifetime, availability and exposure to the metals, has also been assessed. The results show that the total value of these four metals is greater than the range of cancer risk specified by USEPA (1989).

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