

Evaluation of the level of Some Heavy Metals in Tobacco of Domestic and Imported Cigarette Brands Used in Iraq

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Abstract:

Smoking-related diseases can be attributed to the inhalation of many different toxins, including heavy metals, which have a host of harmful health effects. The primary objective of this study was to determine whether local and imported cigarette brands used in Iraq, have they elevated levels of metals or not. Three metals Lead (Pb), Cadmium (Cd) and Chromium (Cr) were determined in tobacco of seventeen brands of imported cigarettes commonly available in Iraq and three Iraqi domestic cigarettes, which were randomly taken from retail market in Baghdad by using flame atomic absorption spectrometry.

The produced data of imported and local cigarette brands were discussed and compared together and with studies from elsewhere. The results obtained showed that mean concentrations of lead for all cigarette brands was 5.87 $\mu\text{g/g}$ dry weight (range 2.27-11.67 $\mu\text{g/g}$), cadmium 0.57 $\mu\text{g/g}$ dry weight (range 0.1-1.57 $\mu\text{g/g}$) and chromium 3.77 $\mu\text{g/g}$ dry weight (range 0.0-11.21 $\mu\text{g/g}$). There was a large variability in Pb, Cd and Cr content of samples of cigarettes. Pb concentration was the highest, followed by Cr while Cd was the lowest. The investigation confirmed that most of the Iraqi and imported cigarettes in Iraq are contaminated with Pb, Cd, and Cr and quantitatively their distribution is clearly above the safer limits of WHO.

Key words: Cigarette tobacco, Smoking, Toxic Metal, flame atomic absorption spectrometry.

Introduction:

Cigarettes are smoked worldwide and contain many other substances besides tobacco, filters, and paper. In fact, over 4,000 compounds have been identified in cigarette smoke [1]. Cigarette smoke is very harmful and toxic for human health [2]. Some of these toxic materials are heavy metals, particularly cadmium and lead inhaled through. The tobacco plant, *Nicotiana tabacum*, is known to readily absorb trace elements from the soil and to

accumulate them in its leaves at unusually high concentrations. This ability, to accumulate metals, is utilized by modern biotechnology to remove metal contaminations from soil. However, with respect to tobacco farming for cigarette production, this ability of *N. tabacum* becomes a health threatening problem [3]. In fact, toxic metals such as Arsenic, cobalt, cadmium, chromium, copper, lead, iron, nickel, manganese and zinc are

found in different cigarette brands [4,5]. Some of these elements are toxic for humans, even at very low levels of intake. The three of the most prevalent chemicals being cadmium, nickel, and lead. [6,7].

Cadmium is highly toxic, and is one of the most important heavy metals when the adverse health effects of smoking are considered. Cigarettes may contain from 0.5 to 3.5 $\mu\text{g/g}$ Cadmium [8]. These are very high levels compared with those in food which are normally below 0.05, $\mu\text{g/g}$. The greater part of Cd in cigarettes (nearly 70%) passes into the smoke [9]. Most of the Cd passes into side stream smoke, thus posing a risk to passive smokers.

In human body Cadmium accumulates in kidneys, mainly in the kidney cortex, where metallothioneins chelate Cd and immobilize it, which may cause tubular dysfunctions and renal end stage failure [10,11]. Further, Cd has been shown to reduce bone mineral density (osteoporosis) and to cause osteomalacia, the combination of which is called itai itai (ouch-ouch) disease. Cd has been linked to the genesis of cancers of the breast, prostate, colon, rectum, kidney and the lung [12,13]. Additionally, cigarette smoke delivered Cd has been shown to reduce birth weight, and although the placenta seems to protect the foetus from maternal Cd, child Cd burden increases soon after birth via breast milk [14]. Finally, Cd is under suspicion to cause cataract, emphysema, hypertension, and cardiovascular disease [15,16,17].

Lead plays a significant role in tobacco toxicity. Tobacco contains Pb-206 and radioactive Pb-210. Non-radioactive Pb-206 is largely derived from atmospheric pollution. The progenitor of radioactive lead (Pb-210) is radon 226 which is produced as a natural radioactive decay product from

igneous rocks [18]. The use of phosphate fertilizers can increase radon gas levels in areas of low concentration.

After smoking tobacco, Pb-210 and polonium are taken into the lungs. The insolubility of lead may result in small quantities of Pb-210 being retained in the lower bronchial lobes within the lungs, where it causes ongoing radiation damage, potentially increasing the risk of tumors, as it decays into Bismuth-210 and Polonium-210 [19]. Other possible health consequences of lead accumulation are hypertension and peripheral arterial diseases [20], as well as cataract [15].

Another heavy metal presents in cigarette smoke is Chromium. It can exist in several oxidation states, although only the trivalent, Cr (III), and the hexavalent, Cr (VI), forms are common in the natural environment. It is known that Cr accumulates in tissue, especially in the lung, its average concentrations in lung tissue were 1.3 $\mu\text{g/g}$ dry weight in non-smokers and 4.3 $\mu\text{g/g}$ in smokers [21]. It must be born in mind that the biological effects of chromium depend on its valency; in the trivalent form Cr is an essential element [22], in hexavalent form it is carcinogenic. Chromium (VI) compounds, mostly hydroxyl radicals, induce DNA-damage (single strand breaks) [23] and have potential cell transforming effects [24]. Other, non-cancerous, effects of Cr on the respiratory tract include ulceration, chronic rhinitis, impaired lung function and emphysema.

Therefore the monitoring of heavy metals in tobacco is essential for protection of the environment and of our health. This study aimed to determine whether local and imported cigarette brands used in Iraq, have elevated levels of Pb, Cd and Cr heavy metals or not and to compare the

produced data of cigarette brands both with each other and with the existing brands in different countries.

Materials and Methods:

Twenty (20) different brands of cigarettes commonly available in Iraq were purchased randomly from local market in Baghdad. These are, Marlboro, Graven"A" , Rothmans, Aspen , Kent , Miami, Afair, Pantly, Gitanes, leader, , Pleasure-light , Davidoff ,Gauloises (Ultra light), Gauloises (Lights) Pine-light , Pine – slim , Ghamdan , Ishtar, Sumer (King size) and Sumer (Super king size).

The average weight of each cigarette brand was determined by weighing 5 sticks of each brand. Composites of each brand were prepared by removing the papers and filters of 5 cigarettes selected from a pack of 20. Care was taken to avoid any source of contamination, so that these preparations were carried out in a clean environment. The samples were dried in an oven at a temperature of 85°C for 14 h and allowed to cool in a desiccator. The method of Elinder *et al* was used [25] . Five grams of tobacco of each cigarette sample was ashed at 500°C in a muffle oven. One gram of the ash was treated with concentrated HNO₃ and heated to near dryness. The digest was taken up in 1 M HNO₃, filtered through No. 4 Whatman filter paper into a 50 ml volumetric flask and made up to volume with deionized water. This was subsequently analyzed for cadmium, lead and chromium using

flame atomic absorption spectrophotometer.

Statistics

Student's p test ($T > t$) = 0.05 was used for the statistical analysis of the differences in heavy metals between imported and local cigarettes samples. The statistical evaluation of factors investigated was carried out using the Statistical Package for Social Sciences (SPSS, Version 20).

Results and Discussion:

The averaged concentrations of heavy metals in Iraqi cigarette brands are presented in (table 1) and (figure 1). The tested Iraqi brands averaged 5.37µg/g (dry weight) Pb (range 4.52-6.97 µg/g), 0.50µg/g (dry weight) Cd (range 0.37-0.71 µg/g) and 2.53µg/g (dry weight) Cr (range 0.75-3.56 µg/g). According to (table 1), there was no significant difference ($p < 0.05$) in cadmium concentrations between cigarette brands. The lowest concentration was recorded in Sumer (super king size) whereas the highest was in Ishtar. Similarly, no significant difference ($p < 0.05$) was observed in cadmium concentrations among the three cigarette brands. While for chromium there was a significant difference ($p < 0.05$) among the three Iraqi cigarette brands .The lowest concentration was recorded in Sumer (king size) with 0.75 µg/g whereas the highest value (3.56 µg/g) was in Sumer (super king size) .

Table 1: Concentration (µg/g) of heavy metals in cigarettes manufactured in Iraq.

NO.	Cigarette types	Concentration of heavy metals		
		Pb Mean µg/g	Cd Mean µg/g	Cr Mean µg/g
1	Sumer (blue) king size	4.643	0.374	0.753
2	Sumer(black)super king size	4.528	0.428	3.557
3	Ishtar	6.968	0.705	3.294
	Mean ±SD	5.37 ±1.38	0.50 ±.18	2.53 ±1.55
	Min.	4.52	0.37	0.75
	Max.	6.97	0.71	3.56
	WHO Permissible limit	0.05	0.05	0.5

The averaged concentrations of heavy metals in imported cigarette brands are presented in (table 2) and (figure 1). It showed a mean Pb concentration of 5.97 $\mu\text{g/g}$ (dry weight) (range 2.27-11.67 $\mu\text{g/g}$). These results were followed by Cd and Cr 0.59 $\mu\text{g/g}$ (range 0.1-1.57 $\mu\text{g/g}$) and 3.99 $\mu\text{g/g}$ (range 0.0-11.21 $\mu\text{g/g}$) for imported cigarettes, respectively.

On other hand, (table 2) showed that among imported cigarette brands, the highest concentrations of Pb element were found in Gauloises Lights (11.67 $\mu\text{g/g}$), Pine -Super slimes (9.01 $\mu\text{g/g}$) and Pine -Lights (8.73 $\mu\text{g/g}$) (imported

cigarettes) while the highest concentration for Cd with 1.57 $\mu\text{g/g}$ was found in Rothmans and the highest concentration Cr with 11.21 $\mu\text{g/g}$ were found in Pine (Lights). The lowest Pb content was in Davidoff and Cd content was in Ghamdan cigarettes with 2.269 and 0.102 $\mu\text{g/g}$ respectively. Whereas lowest Cr content was in Gitanes and Gauloises (Ultra Lights) cigarettes with 0.0 $\mu\text{g/g}$ for both. Therefore, higher concentrations of Pb, Cd, and Cr were observed in imported cigarette brands as compared to local cigarette brands as shown in (table 3).

Table 2. Concentration ($\mu\text{g/g}$) of heavy metals in imported cigarettes

NO.	Cigarette types	Concentration of heavy metals			Origin
		Pb Mean $\mu\text{g/g}$	Cd Mean $\mu\text{g/g}$	Cr Mean $\mu\text{g/g}$	
1	Gitanes	6.683	0.438	BDL	France
2	Graven A	3.377	0.186	2.635	Swiss
3	Miami	7.163	0.178	2.147	USA
4	Ghamdan	3.955	0.102	3.644	Oman
5	Kent	4.438	0.409	1.423	Germany
6	Gauloises (Ultra Lights)	5.435	1.349	BDL	France
7	Pine (Super slimes)	9.010	0.294	5.022	Korea
8	Davidoff	2.269	1.151	1.968	Germany
9	Aspen	2.953	0.203	3.838	Germany
10	Pleasure	7.274	0.432	6.015	Korea
11	Rothmans	5.035	1.570	5.533	England
12	Gauloises (Lights)	11.670	0.764	5.705	France
13	Pine (Lights)	8.730	0.686	11.210	Korea
14	Marlboro	6.414	1.135	5.645	EU
15	Affair (Slim)	6.654	0.227	3.082	UAE
16	Pentley	6.199	0.469	7.791	EU
17	Leader	4.173	0.422	2.295	EU
	Mean \pm SD	5.97 \pm 2.42	0.59 \pm 0.45	3.99 \pm 2.86	
	Min.	2.27	0.10	0.00	
	Max.	11.67	1.57	11.21	
	WHO Permissible limit	0.05	0.05	0.5	

BDL = Below detection limit

EU = European Union

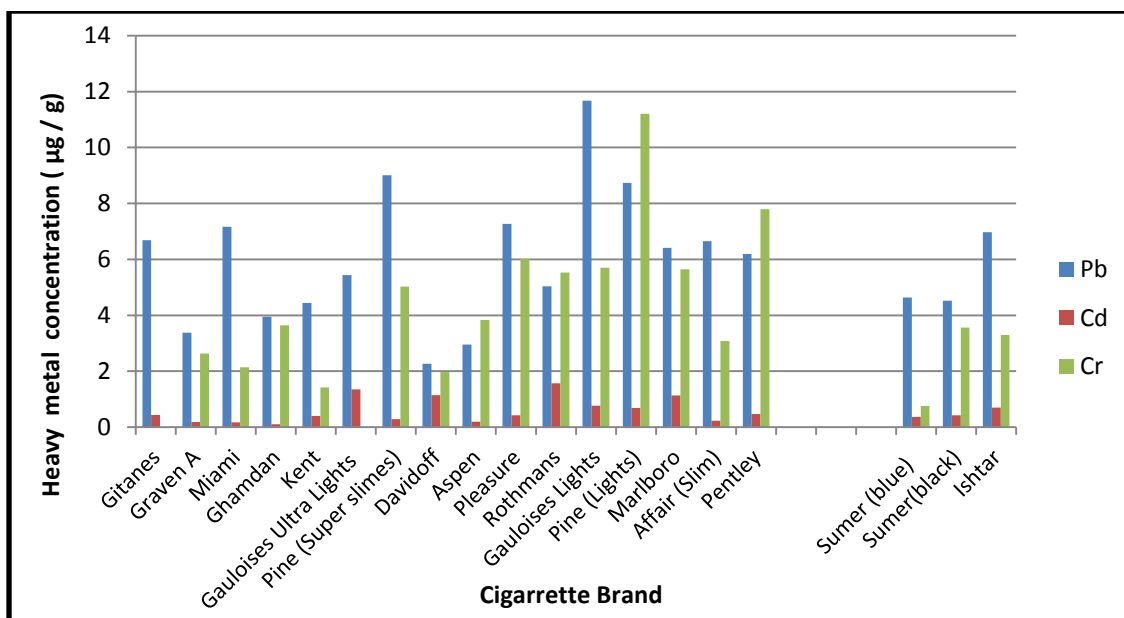


Fig. 1 : Concentration (µg/g) of Pb , Cd and Cr in tobacco of 20 type of Iraqi and imported cigarettes.

Table 3: Comparison of mean concentration of heavy metals contents in Iraqi and imported cigarette brands .

NO.	Cigarette types	Concentration of heavy metals		
		Pb Mean µg/g	Cd Mean µg/g	Cr Mean µg/g
1	Iraqi cigarettes	5.37±1.38	0.50 ±0.18	2.53 ±1.55
2	Imported cigarettes	5.97±2.42	0.59±0.45	3.99±2.86
	Mean ±SD	5.87±2.27	0.57±.419	3.77±2.73
	Min.	2.27	0.10	0.00
	Max.	11.67	1.57	11.21

Results in (tables 1 and 2) also showed that except for chromium element in Gitanes and Gauloises Ultra Lights cigarettes brands, which contain non-detectable amounts of it, all kinds of Iraqi and imported brands were contaminated with lead (Pb), Cadmium (Cd), chromium (Cr). The levels of metals varied considerably among brands. The amounts reveal that, for all metals, the regulatory limits (0.05 µg /g for Pb and Cd and 0.5 µg /g for Cr) [26] are over passed in most of the brands but the level of contamination varies from one cigarette brand to another one. Such variations in heavy metals concentration of tobacco products have been observed by others as well [27]. However, these variations

could possibly be related to agriculture soil and water contents of trace metals on which tobacco leaves were cultivated [28] , type of tobacco, growth conditions, and tobacco treatment process[27]. The mean metal contents of cigarettes also varied markedly depending on the geographical area of production [29].

(Table 4) showed that the mean concentration for cadmium in most tobacco was lower than its degree in some tobacco materials sold and/or produced in Jordan (2.64 µg/g), Turkey (1.1 µg/g), Iran (2.71 µg/g), Saudi Arabia (1.81 µg/g), German (1.95 µg/g), Korea (1.02 µg/g), Nigeria (1.43 µg/g) and USA (0.86 µg/g) .

Table 4. Comparison of the result of studies of heavy metals contents of cigarettes in various countries and results of the present study.

Trace metals $\mu\text{g/g}$			country	References
Pb	Cd	Cr		
5.87	0.58	3.77	-	This study
2.46	1.81		Saudi Arabia	[33]
2.67	2.64		Jordan	[34]
3.7	1.1	5.0	Turkey	[38]
2.07	2.71		Iran	[32]
1.35	1.02		Korea	[30]
1.2	1.95		German	[31]
1.78	1.43	1.95	Nigeria	[35]
1.016	0.0037	ND	Philippines	[36]
0.44	0.86	2.35	USA	[37]

ND= None detectable

(Table 4) also showed that Chromium contents in tobacco brands in Turkey was the highest among all cigarette brands included in this study. In comparison with the reported results for Pb in tobacco materials sold and/or produced in the Jordan (2.67 $\mu\text{g/g}$), Saudi Arabia (2.46 $\mu\text{g/g}$), Turkey (3.7 $\mu\text{g/g}$), Iran (2.07 $\mu\text{g/g}$), German (1.2 $\mu\text{g/g}$), Nigeria (1.78 $\mu\text{g/g}$), Korean (1.35 $\mu\text{g/g}$), Philippine (1.01 $\mu\text{g/g}$) and USA (0.44 $\mu\text{g/g}$), the average concentration of Pb element content in all cigarette's tobacco included in this study was the highest among them with 5.87 $\mu\text{g/g}$. As a result we found that tobacco of Iraqi and imported cigarettes used in Iraq have the lowest concentration of Cd and the highest concentration of Pb.

Because the amount of element absorbed by the body from the smoking process for any type of cigarettes depends on the concentration of element in tobacco [39] so that the high concentrations of toxic elements observed in this study will be harmful to the smokers and passive smokers because when the cigarettes are burned during the process of smoking, metals are retained in the ash with about 70% transferred to the smoke. The metals, distributed in the mainstream smoke, though present in lower concentrations than inside stream smoke, are responsible for the health anomaly in active smokers while those in the side

stream smoke are responsible for some health effect in passive smokers [40].

Conclusion and Recommendations:

The study has confirmed that most of the Iraqi and imported cigarettes found in Iraq are contaminated with lead (Pb), Cadmium (Cd), chromium (Cr) and quantitatively their distribution is clearly above the safer limits of WHO. Thus, increasing in biological levels of at least these metals which are carcinogenic, represents health risks. So it is fitting that the cigarette manufacturers check the levels of these metals during processing before final packaging, and the legislative arm of the government to enact laws that would control cigarette smoking and subject all cigarettes products to quality control tests to monitor levels of these toxic elements.

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تقييم مستوى بعض المعادن الثقيلة في تبغ السجائر المحلية والمستوردة المستخدمة في العراق

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الخلاصة:

تعزى الأمراض المتعلقة بالتدخين إلى استنشاق العديد من السموم المختلفة، بما في ذلك المعادن الثقيلة والتي يعود لها العديد من الآثار الصحية الضارة. الهدف الرئيسي من هذه الدراسة هو تحديد ما إذا كانت العلامات التجارية المختلفة من السجائر المحلية والمستوردة المستخدمة في العراق حاوية على مستويات مرتفعة من المعادن الثقيلة. تم تقدير تراكيز ثلاثة معادن ثقيلة تمثلت بالرصاص (Pb)، الكاديوم (Cd) و الكروم (Cr) في تبغ سبعة عشر علامة تجارية من السجائر المستوردة و ثلاثة علامات تجارية لسجائر منتجة في العراق والتي أخذت عشوائياً من سوق التجزئة في بغداد. تم الكشف عن تراكيز المعادن باستعمال تقنية الامتصاص الذري اللهبى.

تم مقارنة محتوى السجائر المستوردة مع تلك المصنعة في العراق من عناصر الرصاص، الكاديوم و الكروم إضافة لمقارنتها مع الدراسات المماثلة من بلدان أخرى. أوضحت النتائج أن معدل تركيز عنصر الرصاص في عينات التبغ لجميع أنواع السجائر المدروسة في هذا البحث كان 5.87 مايكروغرام/غرام من الوزن الجاف (المدى 2.27-11.67 ميكروغرام/غرام)، الكاديوم 0.57 مايكروغرام / غرام من الوزن الجاف (المدى 0.1-1.57 ميكروغرام / غرام) و الكروم 3.77 مايكروغرام / غرام من الوزن الجاف (المدى 0.0 – 11.21 ميكروغرام/غرام). بينت النتائج وجود تباين كبير في محتوى السجائر المستوردة وتلك المصنعة في العراق من الرصاص والكاديوم و الكروم. إذ كان تركيز الرصاص هو الأعلى، يليه الكروم بينما كان تركيز الكاديوم هو الأقل. نستنتج من هذه الدراسة إن تبغ جميع السجائر العراقية وغالبية السجائر المستوردة المستهلكة في العراق ملوثة بعناصر الرصاص، الكاديوم و الكروم وان تراكيزها تفوق الحدود الآمنة المثبتة من قبل منظمة الصحة العالمية.

الكلمات المفتاحية: تبغ السجائر، التدخين، المعادن السامة، مطيافية الامتصاص الذري اللهبى.