Comparison of the Level of Cadmium and Lead between the Cigarette Filters of Different Iranian and non-Iranian Brands

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ABSTRACT

Background: Cigarette butts have been shown to release numerous kinds of chemicals such as heavy metals in water and may be a continual source of aquatic environments contamination after discarding. The objective of the present study was to determine the concentration of Cd and Pb in cigarette filters of different Iranian and non-Iranian brands in smoked and non-smoked samples.

Methods: Ten different brands of cigarettes were collected from Tehran, Iran local markets in 2014. Standardized international protocols were followed for preparation of the materials and analysis of heavy metals (Pb and Cd) contents. The data were statistically analyzed using SPSS 18 software by ANOVA and Student T tests.

Results: The average concentration of Cd in Iranian cigarette filters was 0.42±0.03mg/kg and in non-Iranian cigarette filters was 0.31±0.05mg/kg (p=0.4). The average concentration of Pb in Iranian cigarette filters was 22.32±1.15mg/kg and in non-Iranian cigarette filters was 23.62±3.17mg/kg (p=0.072). The Cadmium concentration in cigarette filters ranged from 0.18 to 0.48µg/g before and 0.25 to 0.88µg/g after smoking. The Lead concentration in cigarette filters ranged from 16.63 to 33.52µg/g before and 20.14 to 53.55µg/g after smoking.

Conclusion: Smoked cigarette filters have more concentrations of Cd and Pb than non-smoked cigarette filters and these concentrations are also different between Iranian and non-Iranian cigarette brands.

Keywords: Absorption, Radiation; Cadmium; Environmental Pollution; Lead; Smoking.

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INTRODUCTION

Cigarette butts are among the most common forms of litter and it is estimated that approximately 4.95trillion cigarette butts and filters to be littered each year, worldwide [1]. This poisoning kind of wastes accumulates in sewer systems and its chemical components leakage into the local environment is a significant threat to organisms [2, 3]. Cigarette butts have been shown to release numerous kinds of chemicals e. g., heavy metals, nicotine, ethyl phenol, and pesticide residues, in water and may be a continual source of aquatic environments contamination after discarding [2]. Slaughter et al. demonstrated that the median lethal dose for test fish species is approximately one cigarette butt per liter of both fresh- and saltwater [4].

Many chemical agents e.g., pesticides, herbicides, insecticides, fungicides and rodenticides, are used during tobacco plant growing and cigarettes manufacturing which the residues may be found in final products [5]. Additionally, over 4000 chemicals may also be introduced to the environment via cigarette's particulate matter (tar) and mainstream smoke [6].

These include chemicals such as carbon monoxide, hydrogen cyanide, nitrogen oxides, polycyclic aromatic hydrocarbons, ammonia, acetaldehyde, formaldehyde, benzene, phenol, argon, pyridines, and acetone, over 50 of which are known to be carcinogenic [7].

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Although the heavy metals in cigarettes and mainstream smoke have been extensively investigated, few studies have attempted to identify and quantify the components leaked from cigarette butts. Micevska et al. suggest that the toxicity of cigarette butts is in part due to heavy and trace metals [8]. The presence of metals in cigarettes can be attributed to the growth and cultivation of tobacco, soil contamination, pesticide and herbicide application, cigarette manufacturing process and the use of brightening agents on the wrapping paper [9-12]. Cigarette butt wastes are commonly discarded into beaches, sidewalks, streets, parks, and many public places where they contaminate soil and water and increase the concentration of heavy metals which results in adverse effects on some organisms. Lead and Cadmium are present in tobacco smoke and contribute significantly to cancer risk indices [13]. Moerman and Potts have reported that 0.12kg of Cadmium enters the environment from each cigarette litter, which is estimated to be a huge amount each year [2].

The consumption of tobacco products and the number of smokers have been increasing in Iran and the overall prevalence of self-reported cigarette smoking is 14.3% [14]. As the presence of Pb and Cd is highly varied in different cigarette brands [15, 16], The objective of the present study was to determine the concentration of Cd and Pb in cigarette filters of different Iranian and non-Iranian brands in smoked and non-smoked samples.

MATERIALS AND METHODS

Ten different brands of cigarettes (Biston, Bahman, Zica, Farvardin, Caspian, Winston, Marlboro, Montana, Kent, and Magna) were purchased from Tehran, Iran local markets in 2014. To collect the pre-smoked components, cigarettes were separated into tobacco and filter and for post-smoked components, all cigarettes were smoked normally (till the burning line reached the butt length which was different according to different brands) by a unique volunteer. The remaining of the smoked cigarette was also separated into a used filter and a tobacco butt. To avoid any source of contamination, all stages of preparation was conducted in a clean room with maximum care. The samples were dried in an oven at 80°C for 12 hours and cooled in a desecrator.

Standardized international protocols were followed for preparation of the materials and analysis of heavy metals (Pb and Cd) contents. One gram of the filter sample was weighed precisely on D.7455 electronic balance (Bosch; Germany). For analysis of Cd and Pb, the samples were separately put in a 100ml digestion flasks to which 5ml of digestion mixture was added and heated on a hot plate in the fuming chamber for wet digestion with a digestion mixture comprising of concentrated HNO3/HCl (4:1). The samples were analyzed by a Flame Emission Spectrophotometer Model AA-6200 (Shimadzu; Japan), using an air acetylene flame and at least four standard solutions for each heavy metal (Pb, Cd) [17-19]. Coefficient of variations (CV percentage) in determination of the heavy metals in all samples was less than 2.5%. All necessary precautions were taken into account to avoid any possible contamination of the samples according to AOAC guidelines [20]. Quantification was achieved by interpolating the relevant calibration curves prepared from aqueous solutions of metal standards in the same acid concentration, in order to minimize the matrix effects [21].

The data were statistically analyzed using SPSS 19 software by ANOVA (to compare the means of groups) and Student T (to compare the means of Iranian and non-Iranian Brands) tests.

RESULTS

The average concentration of Cd in Iranian cigarette filters was 0.42±0.03mg/kg and in non-Iranian cigarette filters was 0.31±0.05mg/kg (p=0.4). The average concentration of Pb in Iranian cigarette filters was 22.32±1.15mg/kg

and in non-Iranian cigarette filters was 23.62±3.17mg/kg (p=0.072).

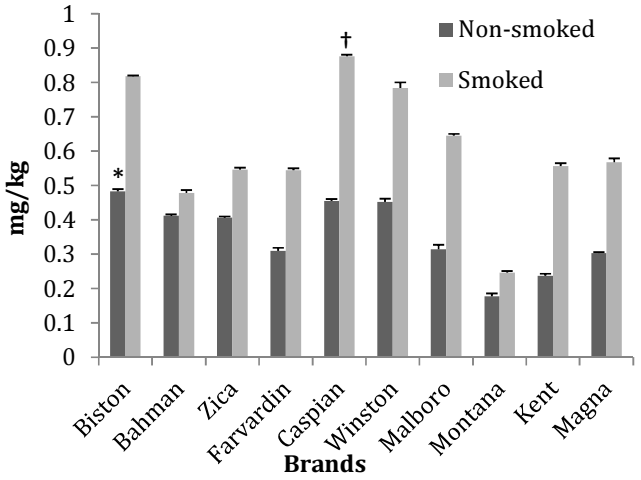

Figure 1. Average of the Cadmium concentration of Iranian and non-Iranian cigarette filters (*p<0.05 significant as compared to other non-smoked brands except Winston and Caspian; †p<0.05 significant as compared to other smoked brands except Biston and Winston).

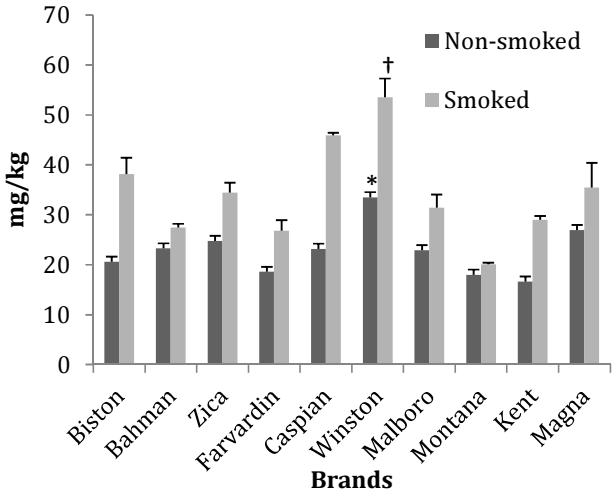

Figure 2. Average of the Lead concentration of Iranian and non-Iranian cigarette filters (*p<0.05 significant as compared to other non-smoked brands except Caspian; †p<0.05 significant as compared to Kent, Montana, Farvardin and Biston smoked brands).

The Cadmium concentration in cigarette filters ranged from 0.18 to 0.48µg/g before and 0.25 to 0.88µg/g after smoking. The Caspian smoked filters and the Biston non-smoked filters had the highest concentration of Cadmium. The Montana had the lowest concentration of Cadmium in both smoked and non-smoked filters (Figure 1).

The Lead concentration in cigarette filters ranged from 16.63 to 33.52µg/g before and 20.14 to 53.55µg/g after smoking. The smoked and non-smoked Winston filters had the highest concentration of Lead, while Montana had the lowest concentration of Lead in smoked filters and Kent had the lowest concentration of Lead in non-smoked filters (Figure 2).

DISCUSSION

The amount of toxic metals absorbed and trapped by filter of different brands of cigarettes were different and played an important role in toxic metal distribution and environmental pollution. In the present study, Cadmium and Lead concentration was compared in cigarette filters of certain Iranian and non-Iranian brands. Since there was no sufficient information about the heavy metals content of Iranian cigarette brands, this study would provide useful information for Iran health organizations.

The understudy analytes, Cd and Pb, were detected in all cigarette brand filters before smoking and were also increased after smoking. The percentage of Cd absorbed and trapped by filter of different branded cigarettes were found ranging from 116 (Bahman) to 234% (Kent) and Pb from 112 (Montana) to 198% (Caspian).

The Cd and Pb content in cigarettes have been reported differently (cigarette tobacco, cigarette filter, or the whole cigarette) in various reports. Kazi et al. have reported no Cd and Pb in cigarette filters before smoking while after smoking they were detected from 0.118 to 0.389µg/cigarette and from 0.0274 to 0.0683µg/cigarette, respectively [16]. Watanabe et al. reported that Cd content in cigarette sampled from various countries ranged from 0.29 to 3.38µg/g [22]. Another study reports that the amount of Cd and Pb inhaled from smoking of 20 cigarettes of Jordan's different cigarette brands is estimated to be 3.65–7.30µg and 0.74–

2.22µg, respectively [23]. Similar results were reported for Cd in cigarette filters in Pakistan that ranged from 1.66 to 2.96µg/cigarette [16], United Kingdom (0.9µg/g) and Korea (1.02µg/g) [24].

As smoked cigarette filters have more heavy metals than the non-smoked cigarette filters, cigarette butt litter can be considered as the potential sources of environmental contamination. Further study is required to determine the mobility of metals in cigarette filters under different conditions.

CONCLUSION

Smoked cigarette filters have more concentrations of Cd and Pb than non-smoked cigarette filters and these concentrations are also different between Iranian and non-Iranian cigarette brands.

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