Determination of Lead and Cadmium in Different Brand of Cigarettes In Pakistan

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Summary: This study has been carried out for the determination of lead and cadmium accumulation in different varieties of cigarette available in the local market of Karachi by Atomic Absorption Spectrophotometry (AAS). Samples of 24 brands of the cigarette were collected randomly from retail out lets of Karachi. In this study total average concentration of lead and cadmium were found in the range of 1.04 - 5.86 and 0.05 - 2.25 $\mu g/g$ respectively. The results are discussed with reference to the mean average concentration in the cigarettes reported in previous studies.

Introduction

Cigarette is one of the means by which nicotine in tobacco is made available for human consumption. Nicotine is recognized to be the major inducer of tobacco dependency [1]. Approximately 5 trillion cigarette are produced each year or 1,000 cigarettes for each man, women and child on the earth [2]. Usually cigarette is made up of tobacco, paper and additives. As much as 600 – 1400 additives are used in cigarette manufacture, with many of these additives containing toxic elements that include Cd and Pb [3].

Cigarette smoke contâins particle and gases generated by the combustion of its various components at high temperature. More than 4000 compounds have been identified in the environmental tobacco smoke [4].

The cigarette smoke can be inhaled directly by the smoker and non-smoker in cigarette-contaminated environment. Cd and Pb are well-known carcinogen [5] and the component of the tobacco. The concentrations of lead and cadmium in cigarette are of importance because of toxicological effects of these metals. Heavy metals in cigarettes are present in the main stream smoke (inhaled by the smoker during a puff), in the side stream smoke (smoke produce mainly between the puff and probably inhaled by non-smokers), in the butt and in the ash [3 - 6]. About 50 % of the Cd mobilized by the smoking process is transferred into the side stream smoke. Whereas the amount of Cd in the main stream smoke increases as the number of puff is increased [7].

A study on the nature and quantities of any elements present in tobacco leaves is important to the tobacco and health researchers [8]. During the last two decades many researchers have used different techniques particularly that of trace metals in tobacco of different brands of cigarettes of various countries [9 - 13]. In this study, we have determined the level of Cd and Pb in cigarettes available in Pakistan and estimate the amount of Cd and Pb inhaled from the consumption of each cigarette.

Results and Discussion

The level of concentration of Pb and Cd in cigarettes available in Pakistan was determined by Atomic Absorption Spectrophotometer (AAS) by standard addition method. The total average concentrations of Pb and Cd along with the weight of cigarette are presented in Table-1. The concentration of Pb and Cd in tobacco or cigarettes reported for various countries is shown in Table- 2.

The average weight of the cigarettes is 0.94 g and ranges from 0.55 g to 1.11 g. The weight of cigarette varies depending upon the length of the cigarettes, for normal size cigarette with 8.2 to 8.9 cm in length with filter the weight ranges from 0.85 to 1.11g per cigarette. However, the weight of long sized cigarette 10 -12 cm in length ranges from 0.55 to 1.01 g per cigarette in the studied cigarette samples. Cigarette filters have been observed to significantly prevent the inhalation of Pb, Cd, Mg and Fe [14].

Determination of Toxic elements Pb and Cd in cigarette is very important because of their biological significance. Although metal concentration in cigarette, vary with the brands of

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Table- 1: Weight and concentration of Pb and Cd in 24 brands of cigarette available in local markets in Pakistan.

Cigarette code	Weight of cigarette (g)	Pb ($\mu g/g$)	Cd ($\mu g/g$)
PK01	0.954	5.86 ± 0.72	0.43 ± 0.02
PK02	0.988	3.10 ± 0.84	0.39 ± 0.08
PK03	0.879	1.83 ± 0.06	2.25 ± 0.08
PK04	1.113	2.68 ± 0.05	0.35 ± 0.19
PK05	0.877	2.99 ± 0.80	0.44 ± 0.18
PK06	1.011	1.88 ± 0.37	0.17 ± 0.06
PK07	0.929	1.04 ± 0.09	0.04 ± 0.00
PK08	0.949	2.60 ± 0.23	0.78 ± 0.01
PK09	0.904	4.77 ± 0.06	1.18 ± 0.06
PK10	0.955	3.31 ± 0.35	0.67 ± 0.05
PK11	0.893	3.21 ± 0.66	0.27 ± 0.04
PK12	0.883	4.28 ± 0.29	0.56 ± 0.31
PK13	0.892	3.05 ± 0.89	0.52 ± 0.04
PK14	0.858	2.26 ± 0.78	0.91 ± 0.36
PK15	0.992	4.24 ± 0.16	0.52 ± 0.15
PK16	0.955	3.47 ± 0.49	0.86 ± 0.40
PK17	1.051	3.82 ±0.94	0.36 ± 0.02
PK18	0.989	1.49 ± 0.37	0.39 ± 0.11
PK19	1.011	2.52 ± 0.09	0.43 ± 0.06
PK20	1.108	4.37 ± 0.63	0.34 ± 0.04
PK21	0.964	1.48 ± 0.79	0.65 ± 0.09
PK22	0.550	3.84 ±0.28	1.02 ± 0.29
PK23	1.019	3.30 ± 0.40	0.83 ± 0.16
PK24	0.914	2.28 ± 0.77	0.58 ± 0.17
Mean	0.944	3.07	0.62
Maximum	1.113	5.86	2.25
Minimum	0.551	1.04	0.04

Table- 2: Concentration of Pb and Cd in Tobacco/ Cigarettes available in various Countries.

Country	Cd		Pb	
	Range ($\mu g/g$)	Mean ($\mu g/g$)	Range ($\mu g/g$)	Mean ($\mu g/g$)
China	0.10 - 4.95	1.48	-	-
Finland	0.70 - 1.90	1.70	1.30 - 3.30	2.40
Germany	0.56 - 2.14	-	-	-
France	-	1.85	-	1.13
India	0.22 - 0.49	-	0.31 - 0.42	-
Korea	0.91 - 1.13	1.02	0.88 - 2.13	1.35
New Zealand	0.23 - 0.56	-	0.48 - 0.55	-
UK.	0.69 - 1.10	0.90	0.45 - 1.35	0.74

cigarette and methodology of chemical analysis. It is accepted that Pb and Cd concentration in cigarette generally range from 1 to 3 $\mu g/g$ in Pb and from 1 to 2 $\mu g/g$ in Cd, respectively [9 - 13].

Many studies on Pb concentration in cigarettes have been under-taken in various countries (Table- 2). Watanabe *et al,* [15] reported that Pb concentrations in the cigarettes of 331 brands from 20 countries ranging from 0.46 to 43.66 $\mu g/g$, with an average value of 2.08 $\mu g/g$. Table- 1 shows that in the present study the mean concentration of Pb was recorded in the range of 1.04 to 5.86 $\mu g/g$, with mean value of 3.07$\mu g/g$, which is higher than that reported for France [7], Finland, Korea, United Kingdom [15], India [16], New Zealand [17] and Germany [18] (Table- 2). Watanabe *et al,* [15] also reported that the concentration of Cd in cigarettes from various countries ranged from 0.1 to 4.95 $\mu g/g$ with average value in the range of 0.90 to 1.85 $\mu g/g$. Table- 1 also shows that the level of Cd in cigarettes recorded in this study in the range of 0.04 to 2.25 $\mu g/g$, with mean value of 0.627 $\mu g/g$, which is lower than that reported for France [7], China, Finland, France, Korea, United Kingdom [15], India [16], New Zealand [17] and Germany [18]. But our results agreed with the earlier studies [9 - 13] that the range of Pb in cigarette is from 1 to 3 $\mu g/g$ and Cd is from 1 to 2 $\mu g/g$ in cigarettes.

The major source of Pb and Cd in tobacco smoke and high concentrations of these trace metals in tobacco leaves and cigarette may result from the wide spread use of chemical fertilizers and pesticides and irrigation with the residual water [19]. The processing, packaging and other technological processes (including the use of additives) used to bring raw food items to the consumers can significantly increase the total concentration of trace metals in the finished products [20].

A potential role of cigarette smoking has been established by a series of epidemiological studies. Smoking of cigarettes accelerates and aggravates cardiovascular diseases and is casually associated with increases risk of chronic obstructive lung diseases, lung cancer and upper aerodigestive system [1]. Cigarette smoke impairs both male and female fecundity and may potentiate the effects of other suspective reproductive toxicants such as caffeine [21- 22]. Although, the level of Pb and Cd in the blood of smokers is higher than that of non-smokers, it is more likely that the negative effects of smoking on human health are observed. Not only are the smokers at risk, a positive correlation has also been observed between the degree of passive exposure to cigarettes smoke and concentration of components of cigarettes smoke on human health [22].

The World Health Organization has estimated that each year tobacco contributes to the premature deaths of at least 4 million people, from 25 illnesses, including heart diseases, lung cancer, other cancers, bronchitis, emphysema and stroke. The annual death toll from smoking related diseases is projected to reach 10 million by 2030 (70 % of them in developing countries) an average of about 27,400 preventable death/ day [23]. The report of international (WHO/ UNEP) program for assessment of human exposure to heavy metals, reported higher level of Cd in kidney cortex samples of smokers compared to non-smokers in Europe, United States and Japan [24]. Significantly higher concentration of Cd and Pb, have also been reported in blood [25], hair [26] and in saliva of smokers [3].

Experimental

Materials and Methods

Samples of various brand of Pakistani cigarette were selected for the determination of lead and cadmium. Twenty four brands of cigarettes commonly available in Pakistan were purchased from retail outlets in Karachi and analyzed for lead and cadmium.

The average weight of each brand of cigarette was determined by weighing 3 stick of each brand of cigarette. The samples were dried in an oven at a temperature of 80 $\pm$ 1 °C for 12 h and allowed to cool in a desiccator. The digested samples were dissolved in an acid mixture containing 10 ml of 65 % HNO_3 and 4 ml of 60 % $HClO_4$. Organic matters were decomposed and metal ions were changed into their respective nitrates. The mixture is then filtered through No.4 Whatman filter paper into a volumetric flask and made upto 50 ml by adding deionized water. All the glassware were extensively soaked with diluted HNO_3 and rinsed twice with distilled water.

Table- 4: Recovery of Metals added to the igarettes

Metal	Spike Level (ppb)	No of Samples	Mean observed value (ppb)	Percent Recovery (%)
Pb	25	05	23.2	92.8
Cd	0.5	05	0.48	96.1

All reagents used in this study were ultra pure or analytical reagent (A.R.) grade. Distilled and deionized water was used for dilution and preparation of reagents and standards. Reference standards were prepared from BDH spectrosol AA standard (1000 *mg/ kg*) [27]. Analysis was performed on Atomic Absorption Spectrophotometer (Hitachi Z-8000), with Zeeman Effect background correction. The Spectrophotometer is equipped with a graphite furnace, a microprocessor and a built-in printer. Determination of Pb and Cd was carried out by flameless (ETAAS) Atomic Absorption Spectrophotometry, employing the standard addition techniques. Measurements were made by using the hollow Cathode Lamp for Pb and Cd. The working condition for this technique is presented in Table- 3.

Table- 3: Working Condition of Atomic Absorption Spectrophotometer for Lead and Cadmium.

Element	Slit	Wavelength (nm)	Drying Temperature (°C)	Ashing Temperature (°C)	Atomization Temperature (°C)
Pb	1.3	283.3	80 - 120	400	2000
Cd	1.3	228.8	80 - 120	300	1500

Three separate readings were taken for each sample and the mean values of these figures were used to calculate the result. Accuracy was also monitored by spike, with lead and cadmium in the level of 25 and 0.5 *μg/ kg*, respectively. Analysis was done in replicates, the samples analyzed in parallel following analytical procedure used in this work. Accuracy was verified by means of recovery essay. Five cigarette samples were spiked with Pb and Cd at various levels to determine the recovery of lead and Cadmium. The average recovery for Pb and Cd are given in Table- 4.

Conclusions

Tobacco consumption through cigarettes is a problem assuming an alarming proportion in the world. The observation is that it is becoming increasingly difficult to quit smoking. This study shows that the level of Pb and Cd in cigarettes available in Pakistan compares well with the levels in cigarettes from other parts of the world. The data hare obtained will be valuable in complementing available data on Pb and Cd exposure from cigarette consumption and in estimating dietary intake of heavy metals in Pakistan. Efforts should be made by the government at discouraging the consumption of cigarettes.

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