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Full Length Research Paper

Levels of cadmium in different brands of cigerettes sold in Abakaliki metropolis of Nigeria

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Cadmium (Cd) is recognized as category 1 carcinogen by the international agency for research on cancer based on its relationship to pulmonary tumors. Cigarette smoking is one major source of Cd in the environment. Levels of Cd in 19 different brands of cigarettes (both local and foreign made) sold in Abakaliki town were determined using atomic absorption spectrophotometer (AAS) (205). The results showed varied levels of Cd in different brands of cigarettes analyzed. On the average, locally made cigarettes contained higher levels of Cd than the foreign brands, except Dorchester which contained 0.259 ug/g. London, Benson and Hedges and Marlboro red contained 0.389, 0.680 and 0.329 ug/g Cd, respectively, the results also showed that different brands of cigarette contained varied quantities of tobacco per stick. However, the quantity of tobacco per stick of cigarette did not correlate with the level of Cd it contained. Brands like excel, green spot, business club, consulate, London, Benson and Hedges and Marlboro which contained 0.66, 0.821, 0.786, 0.670, 0.736 and 0.650 g of tobacco/stick of cigarette, respectively, had 0.043, 0.087, 0.043, 0.1517, 0.3899, 0.3863 and 0.1299 µg of Cd, respectively. In addition to emphasizing the danger of cigarette smoking, the results highlight the Cd-toxicity potential of each brand of cigarette. Thus some brands can be more poisonous than others based on their Cd contents. Smoking in public places should be banned to reduce the public health consequences of Cd intoxication due to uncontrolled emission of Cd into the environment via cigarette smoking.

Key words: Cigarette brands, cadmium, smoking, intoxication.

INTRODUCTION

The outbreak of 'itai-itai-byo'' or ''ouch-ouch'' disease (a crippling rheumatoid bone disease; *`itai`* = pain, *`byo`* = disease) in Japan in 1945 was the historical event that drew the world's attention to the environmental hazards of Cd poisoning for the first time. The disease was as a result of produce from rice paddies irrigated by contaminated stream (Yu, 2001). Cd is considered to be one of the most toxic trace elements and has no known physiological role (Yu, 2001). Cd is a non-essential trace element present in air, water and food. A variety of industrial activities can lead to Cd exposure. Examples includes mining and metallurgical processing, combustion of fossil fuel, textile printing, recycling of ferrous scrap and motor oils and disposal and incineration of Cd-containing products. Cd persists in the environment and has a biological half-life of 10 to 25 years (Klaassen, 2001).

Tobacco in all its forms contains appreciable amounts of Cd and tobacco smoke is one of the largest single sources of Cd exposure in humans (Yu, 2001). Each cigarette on the average contains approximately 1.5 to 2.0 µg of Cd, 70% of which passes into smoke (Yu, 2001; Klaassen, 2001). Since the absorption of Cd from the lungs is much higher than from the gastrointestinal tract, smoking contributes significantly to the total body burden. Although dietary intake is the means by which humans are usually exposed to Cd, inhalation of Cd is more dangerous than ingestion of the metal. This is because through inhalation the organs of the body are more directly and intimately exposed to the metal. Moreover 25 - 40% of inhaled Cd is retained, while only 5 to 10% of ingested Cd is absorbed (Yu, 2001; Norberg, 1996). On absorption, Cd is bound to the albumin. The bound Cd is

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quickly taken up in the tissues, preferentially by the liver. In the liver the Cd is bound with MT and cycles through blood, kidney and to small extent, bone and muscle tissue. Excretion of Cd in mammals seems minimal under normal exposure. Miniscale amounts are excreted in the faeces and an immediate 10% excretion may occur in urine (Yu, 2001).

As with other heavy metals, Cd binds rapidly to extracellular and intracellular proteins, thereby disrupting membrane and cell function. Patients with low in-take of Ca and vitamin D are particularly at high risk of Cd poisoning. Vitamin C supplementation with Fe markedly reduces Cd accumulation in various soft tissues of rats. It has greater affinity for thiol ligand than does Zn, it binds to sulfur-containing ligands (Goyer and Clarkson, 2001).

The aim of this study was to assess the level of Cd in different brands of cigarettes smoked in Abakaliki metropolis and compare the results with Cd contents of some selected food found in the literature and then based on information from literature, evaluate the health implications of smoking each brand of cigarettes based on its Cd content. This will be necessary to advise the public on the risk of Cd-intoxication associated with each brand of cigarette.

MATERIALS AND METHODS

Cigarette samples

The cigarette samples used in this study were sourced from the Abakpa main market, Abakaliki. 19 brands of cigarettes comprising 6 brands foreign (Club, LD menthol, gold bond, harbour, Aspen and Dorchester) and 13 brands, Nigeria (Greenspot, excel, forum, SM, consulate, business club, St Moritz, Rothmans, Malboro, Pall Mall, London, Benson and Hedges and Malboro light), were chosen.

Chemicals

Chemicals used in this study were purchased from Sigma-Aldrich chemicals (Poole, UK), VWR (Lutterworth, UK) and Fisher Scientific (Loughborough, UK). Other chemicals used were of the purest analytical grade commercially available.

Determination of cadmium content of cigarette brands

Ashing was carried out by putting exactly 5 g of tobacco from each brand of cigarette into a crucible in a muffle furnace, which had been heated to 500°C and cooled in a desiccator. The furnace was then heated again to 500°C for 3 h, until ashing was completed. When the ashing was complete, it was put into a foil paper and weighed. Digestion was carried according to Uzoukwu, (2004) and Vogel, (2002). Cd concentration in each sample of cigarette was determined using atomic absorption spectrophotometer at 229 nm (Agrawal and Sadhkar, 2002). This analytical procedure provides a quick, sensitive and precise method for determination of metal ions in solution.

Statistical analysis

Statistical analysis was done using the one-way analysis of variance (ANOVA) as contained in the SPSS/PC$^+$ package and the differences between means were compared using the Duncan's (1955) multiple range test.

RESULTS

The results of levels of Cd in different brands of cigarettes sold in Abakaliki metropolis are presented in Table 1. Presented in Table 2 are the results from literature showing the levels of Cd in some selected foods (Yu, 2001). The results showed that different brand of cigarette contained different amount of Cd. On the average, most of the locally made cigarettes contained higher levels of Cd than the foreign brands. Locally made brands like London, Benson and Hedges and Marlboro red contained 0.389, 0.368 and 0.329 µg of Cd per stick of cigarette, respectively, while Dorchester, Harbour and Gold bond contained 0.259, 0.086 and 0.064 ug/g Cd, respectively. The differences in Cd content between the local and foreign brands are statistically significant at 95% confidence level. Thus among the locally made cigarettes, London contained the highest level of Cd per stick, while business club contained the lowest level of Cd. Marlboro red contain higher level of Cd per stick than Marlboro light. Among the foreign brands, Dorchester contained the highest level of Cd, while Aspen contained the lowest level of Cd. The results also showed that different brands of cigarette contained varied quantities of tobacco per stick of cigarette. However, the quantity of tobacco per stick of cigarette did not correlate with the level of Cd it contained. Brands like Excel, Green Spot,, Business Club, Consulate, London, Benson and Hedges and Marlboro which contained 0.66, 0,821, 0.786, 0.669, 0.736 and 0.650 g of tobacco per stick, respectively, were found to have 0.043, 0.087, 0.043, 0.152, 0.390, 0.386 and 0.130 µg of Cd per stick of cigarette, respectively.

DISCUSSION

Cadmium (Cd) is considered to be one of the most toxic elements in the environment (Yu, 2001). Cd has been accepted by the International Agency for Research on Cancer (IARC) as category 1 (human) carcinogen based primarily on its relationship to pulmonary tumour (IARC, 1994). In Nigeria today, every person is a passive smoker because of lack of restriction to smoking. A smoker does not only poison oneself, but also the general public with its subsequent adverse economic and health conesquences.

Our results highlight the Cd toxicity potential and the possible health implications of each brand of cigarettes smoked in Abakaliki and elsewhere. People who smoke London, Benson and Hedges, Marlboro, Dorchester and Consulate are more likely to suffer from Cd intoxication than those who smoke Excel, Green Spot, Aspen, Club, Gold and Harbour based primarily on their levels of Cd. However, this is not to encourage smoking in any form, rather while emphasizing the grave consequences of

Table 1. Comparison of levels of Cd in different brands of cigarettes sold in Abakaliki town, Nigeria.

Brand (Local):	Quantity of Cd in Ash µg/g (30%)	Quantity of Cd in Smoke (70%) (Yu, 2001)	Total Cd (mean) Per stick (µg/g)	Quantity of Tobacco per Stick of Cigarette (g)	% of Cd per stick of Cigarette
Green Spot	0.020[a]	0.0667[c]	0.0867[b]	0.821	1.056×10^{-5}
Excel	0.010[a]	0.0333[d]	0.0433[d]	0.661	6.55×10^{-6}
Forum	0.025[a]	0.0833[c]	0.1083[a]	0.725	1.49×10^{-5}
SM	0.025[a]	0.0833[c]	0.1083[a]	0.667	1.62×10^{-5}
Consulate *	0.035[a]	0.1166[a]	0.1516[a]	0.723	2.096×10^{-5}
Business Club	0.010[a]	0.0330[d]	0.0433[d]	0.786	5.51×10^{-6}
St Moritz *	0.023[a]	0.0766[c]	0.0996[b]	0.870	1.145×10^{-5}
Rothmans	0.031[a]	0.1033[a]	0.1341[a]	0.717	1.87×10^{-5}
Marlboro	0.076[b]	0.2533[b]	0.3293[c]	0.650	5.066×10^{-5}
Pall Mall	0.029[a]	0.0966[a]	0.1256[a]	0.731	1.72×10^{-5}
London*	0.090[b]	0.2990[b]	0.3899[c]	0.669	5.82×10^{-5}
Benson & Hedges*	0.085[b]	0.2830[b]	0.3630[c]	0.736	4.93×10^{-5}
Marlboro Light	0.030[a]	0.0999[a]	0.1299[a]	0.650	1.99×10^{-5}
Foreign					
Club	0.015[a]	0.4999[e]	0.06499[b]	0.733	8.86×10^{-6}
LD Menthol	0.020[a]	0.0660[c]	0.0866[b]	0.640	1.35×10^{-5}
Gold Bond	0.015[a]	0.0499[c]	0.0649[b]	0.607	1.07×10^{-5}
Harbour	0.020[a]	0.0660[c]	0.0866[b]	0.792	1.09×10^{-5}
Aspen	0.010[a]	0.0330[d]	0.0433[d]	0.753	5.75×10^{-6}
Dorchester	0.060[b]	0.1990[b]	0.2599[c]	0.659	3.94×10^{-5}

The results are means of triplicate determinations. The standard deviations were either very negligible or not at all and were thus not represented. Values with the same superscript letters are not statistically significant at 95% confidence level (ANOVA).
* British-American Tobacco Company of Nigeria

Table 2. Cd contents of selected foods.

Type of Foods	Cd Contents µg/g wet weight
Dairy products	0.01
Wheat flour	0.07
Leafy vegetables	0.14
Potatoes	0.08
Garden fruits and other fruits	0.07
Sugar and adjuncts	0.04
Meat, Fish, Poultry	0.03
Tomatoes	0.00
Grain and Cereal products	0.06

Culled from Yu (2001).

smoking, we caution that those who must smoke because of their addiction to cigarette smoking might be at less risk of Cd-intoxication if they choose cigarettes with lower levels of Cd. This would lower the levels of Cd inhaled or absorbed into their system. As much as 70% of Cd content of cigarette is contained in the smoke, while about 30% is contained in the ash (Yu, 2001).

Cd toxicity in humans includes injury in the kidney, emphysema and lung cancer (Yu, 2001). It interacts with membrane targets to block Ca transport routes thereby causing deficient uptake and transport of Ca through the cells, leading to an increased excretion of Ca and protein in the urine (Yu, 2001). In man Cd overload inhibits alkaline phosphatase and ATPase of myosin and pulmonary alveolar macrophage cells. The mechanism of enzyme inhibition is through binding of SH group on enzyme molecule and through competition with Zn and displacing it from metalloenzymes (Yu, 2001). Cd can antagonize several essential metals such as Zn, Cu, Se and Fe. Cd has been shown to decrease serum Zn content and adversely affect insulin level and glucose tolerance (Hamilton and Valberg, 1994). Cd affects CNS through displacing Ca from its action site in the neuromuscular junction. Cd exposed rats showed decreased Ca absorption and inhibits activation of vitamins D (Gunter, 1997; Yu, 2001; Klaassen, 2001). Thus smoking cigarettes with high levels of Cd may accelerate the manifestations of these conditions.

One biomarker for measuring Cd-exposure is increased

Cd excretion in urine. For non-smokers in the general public urinary Cd excretion is both small and constant (< 2 µg/l) (Gunter, 1997). Increase in urinary Cd may not occur until all of the available Cd binding sites are saturated with MT. There is good correlation between MT and Cd in urine in workers with normal or abnormal renal function (Shaikh et al., 1989). Thus measurement of MT in urine provides the toxicological information as the measurement of Cd and does not have the problem of external contamination. Blood Cd level generally reflect recent exposure rather than accumulated body burden and are usually in the range 0.4 to 1.0 µg/l for non-smokers (Laurwerys et al., 1994). Workers with cumulative Cd exposure equivalent to a blood Cd concentration of 10 µg/l for 20 years have been shown to have a 14% incidence of renal dysfunction (Jarupe et al., 1988). Recommended urinary Cd level range from 2.4 to 11.5 µg/l creatinine. Occupational exposure should not exceed 5 µg of Cd per gram of creatinine (Roels at al., 1999).

However, cigarettes are not the only sources of Cd to man. It is also found in fruits and vegetables (Table 1). A comparison of our results with those of Cd contents of some selected food samples from literature (Yu, 2001; Klaassen, 2001) showed that a stick of cigarette contains more Cd than most foods (Table 2). Besides, inhalation of Cd is more dangerous than ingestion of the metal. This is because through inhalation, the organs of the body are more directly and intimately exposed to the metal. About 50% of Cd in fumes of inhaled Cd is absorbed, while 5 - 10% of ingested Cd is absorbed (Yu, 2001).

In conclusion, in as much as we do not support smoking of cigarette, we advise that care should be taken on the brand of cigarette one smokes. Some brands are more dangerous than others based on their Cd content. More importantly, cigarette smoking in the public places should be banned to reduce the public health conesquences of Cd intoxication due to uncontrolled emission of Cd into the environment through smoking. Because of the health implications of cigarette smoking, partly due to its Cd content and its consequent emission into the environment, smoking has been banned in public places in most developed countries. It is time for us to do something before the doom day comes.

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