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Analysis of some metallic impurities in Soft Drinks using Atomic Absorption Spectrometer

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ABSTRACT: The present study investigates the concentration of cadmium and lead in eight different brands of Soft Drinks, available at local market of Raipur. Soft Drinks were purchased and brought to the laboratory. The samples were analyzed using standard methods of AFA AWA (2005). The range of lead detected was 0.34 to 0.47 mg/l., which is more than the permissible limit prescribed by WHO (0.01 mg/l) and IS (0.1 mg/l, No.2346-1973). The lowest value obtained for cadmium was 0.030mg/l and highest was 0.038 mg/l. This value was far above the MCL and MCLG of NIS (0.003 mg/L) as well as those of WHO and EPA (0.005 mg/L). According to the result of the present study lead and cadmium are present in soft drinks beyond acceptable limit. The habitual intake of soft drinks especially in summer season by the aged, children, and pregnant women can lead to over accumulation of toxic heavy metal in the body and hence toxicity.

KEY WORDS: Soft drinks, toxic metals, lead, cadmium, permissible limit

I. INTRODUCTION

Soft drinks, also known as ready-to-drink beverages are sweetened water-based non-alcoholic beverages, mostly with balanced acidity (Eyong et al., 2010). The soft drinks are mostly carbonated usually prepared from a concentrated syrup containing sugar, flavouring essence, citric acid and a preservative, Sodium Benzoate (Ofori et al., 2013). Usually the constituents of the drinks are mainly water, carbon dioxide (in the case of carbonated drinks), and syrup that characterizes the flavor of the drink [National Soft Drink Association (NSDA)]. The presence of metallic impurities in soft drinks can constitute health hazards to the public. Due to the recent spate in the consumption of these soft drinks, it has become particularly important to determine the elemental contents of these drinks, (Onianwa et al.,1999, Krepcioet al., 2005, Adepoju-Belloet al., 2012).

Cadmium (Cd) and its compounds are extremely toxic at all levels and tend to bio-accumulate in organisms and ecosystems (ATSDR, 1999). Other health effects that can be caused by cadmium are: diarrhea, stomach pains and severe vomiting, bone fracture, reproductive failure and possibly even infertility, damage to the central nervous system, damage to the immune system, psychological disorders, and - possibly DNA damage or cancer development. Cadmium poisoning causes softening of the bones and kidney failures and was responsible for the “itai-itai” disease (a name derived from the painful screams in Japanese language) due to the severe pain in the joints and the spine (ATSDR, 1999).

Lead poisoning damages the nervous system, kidneys, liver and cause sterility, growth inhibition, developmental retardation (Von Schimding et al, 2001). Children are more sensitive to the effects of lead than adults (Linton et al., 1980). A child who swallows large amounts of lead may develop blood anemia, kidney damage, severe stomachache, muscle weakness, and brain damage (Thornton et al., 1994). The lower IQ levels and other neuropsychological deficiencies among the children exposed to higher lead levels have been well documented (Kotok et al., 1977).

Environmental pollution is the main cause for these heavy metals contamination in the food chain. Lead and cadmium are two potentially harmful metals that have aroused considerable concern (Cabrera et al., 1995). Atmospheric contamination, the excessive use of fertilizers and pesticides, and sewage sludge or irrigation with residual waters is among the causes of contamination of raw foodstuffs (Demirozu & Saldamli, 2002). As a result of the soil, atmosphere, underground and surface water pollution, our foods and beverages are getting contaminated with heavy metals

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(Krejpcio et al., 2005). Because of their high toxicity, arsenic, lead and cadmium need to be quantified in food and beverages (Barbaste et al., 2003).

II. MATERIAL AND METHODS

All the standard solutions were prepared from analytical grade compounds of Merck Company. All the glassware used was of Borosil. Prior to all chemical analyses, the reagent bottles, beakers, and volumetric flasks were cleaned by soaking overnight in 2N hydrochloric acid, rinsed with water oven. Total eight samples of bottled soft drinks like thums up, mirinda, fanta, sprite, sting, coca cola, pepsi, fizz, 7up were purchased and brought to the laboratory from local grocery stores in the commercial city of Raipur. Prior to analysis, the samples were digested according to the method of Wallace (2001). In this method, 10 ml of 69%concentrated nitric acid was added to 20 ml of the sample and the mixture was evaporated on a hot plate in a fume cupboard until the brown fumes disappears leaving white fumes. If brown fumes persist, 5 ml of 69%concentrated nitric acid and 5 ml of 30% H202 was added after cooling the sample. Refluxed the sample at 90^0C until reduces to 2-5 ml. Subsequently, additional distilled water was added to make up the volume to 100 ml which was then filtered with whatman filter paper and ready for atomic absorption spectrophotometer (AAS) analysis using the Varian AA240 model. A working solution of 100 ppm was pre-pared from the stock solution and serial dilutions were made. The absorbance of these solutions was obtained using AAS at 228.8, 283.3nm for cadmium and lead.

III. RESULT AND DISCUSSION

The values determined for lead and cadmium are presented here in the Table 1. Lead and cadmium were detected in all the samples.

As defined by the United States Environmental protection agency, the standard for the determination of heavy metal contamination in soft drink is based on two units of measurements; the maximum contaminant level goal (MCLG) and maximum contaminant level (MCL). MCLG is the level of a contaminant in drinking water below which there is no known or expected risk to health and hence allow for a margin of safety and are non-enforceable public health goals. On the other hand, MCL is the highest level of a contaminant that is allowed in drinking water. The MCLG and MCL are measured in milligrams per liter (mg/L) which is equivalent to parts per million (EPA, 2011).

Table: 1 Mean values of concentration (mg/l) of lead and cadmium in different samples of Soft Drinks (*Standard Deviation)

Sample	*Pb*	*SD**	*Cd*	*SD**
1.	*0.42*	*0.012*	*0.037*	*0.007*
2.	*0.36*	*0.010*	*0.030*	*0.006*
3.	*0.42*	*0.012*	*0.035*	*0.007*
4.	*0.47*	*0.013*	*0.038*	*0.007*
5.	*0.41*	*0.012*	*0.036*	*0.007*
6.	*0.39*	*0.011*	*0.032*	*0.006*
7.	*0.34*	*0.010*	*0.028*	*0.005*
8.	*0.39*	*0.011*	*0.035*	*0.007*

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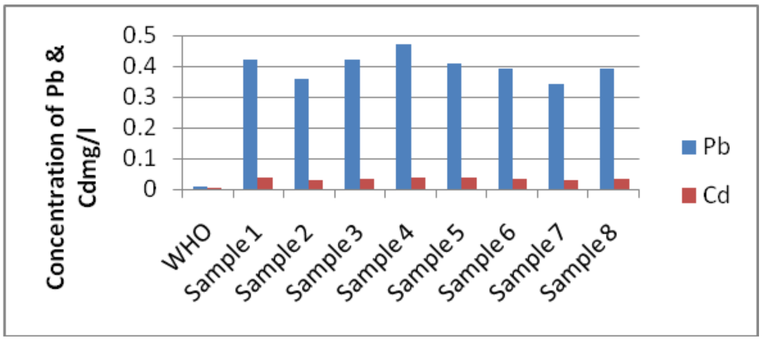

Fig. 1: Comparison of Concentration of elements (Pb and Cd) in the samples of Soft Drinks Lead and cadmium were detected in all the samples.

The range of lead detected was 0.34 to 0.47 mg/l., whereas the maximum permissible limit of lead in soft drinks prescribed by WHO is 0.01 mg/l. Thus all the samples have lead content more than permissible limit of WHO and also more than 0.1 mg/l which are recommend by the IS (No.2346) (1973). The lowest value obtained for cadmium was 0.030mg/l and highest was 0.038 mg/l. This value was far above the MCL and MCLG of NIS (0.003 mg/L) as well as those of WHO and EPA (0.005 mg/L). As presented in the figure1.

The research performed in England revealed that the heavy metal levels in the non-alcoholic beverage samples were within the standard. In this study lead, arsenic, and cadmium contents were determined as 0.02–0.05 mg/kg, < 0.1 mg/kg, and 0.0004–0.001 mg/kg, respectively, in total 100 samples (Maff, 1998). These cadmium and lead contamination values in the samples were found to be very less than our results. Previous studies in Nigeria have also confirmed the presence of cadmium in soft drinks and have shown the level to be above the tolerated limit. Onianwa *et al*. (2001) reported cadmium, copper, lead, and zinc levels as 0.002- 0.005 ppm, 0.10 - 0.10 ppm, 0.04 - 0.01 ppm, 0.15 - 0.03 ppm, respectively, in carbonated soft drinks in Nigeria. These results of lead and cadmium are far less than ours but concentration of copper was more than present reported values. Maduabuchi et al. (2006) reported cadmium levels as 0.002–0.0073 mg/l in canned drinks and 0.092 mg/l in non-canned drink. These lead levels were lower than those determined in our research. A study by Al-Mudhaf (2016) of the levels of 25 trace and heavy metals in total 29 soft drinks samples indicated that none of the metals exceeded either the US-EPA or the WHO maximum recommended levels for drinking water. The levels of micronutrient and toxic metals were found much lower than that mention in the published work worldwide.

VI. CONCLUSION

A long-term and/or excessive consumption of foods containing heavy metals above the tolerance levels has a hazardous impact on human health. Because soft drinks are widely consumed, they contribute a large fraction to the heavy metals intake and, therefore, strict control of these elements is advisable. For this reason, the steps in all processes must be monitored for preventing the contamination by heavy metals.

It is clear from the present research that all the samples have seriously high level of lead and cadmium. Lead and Cadmium toxicity is well documented and recognized as major environmental health risks throughout the world (Bingol et al., 2010) (Krejpcio et al., 2005) and (Rubio et al., 2006). Lead affects humans and animals of all ages, however, the effects of Lead are most serious in young children (Adepoju-Bello, 2012). Cadmium is a toxic and carcinogenic element (Krejpcio et al., 2005 and Rubio et al., 2006).Cadmium intake in relatively high amounts can be detrimental to human health. Over a long period of intake, Cadmium may accumulate in the kidney and liver and because of its long biological half life, may lead to kidney damage (Maduabuchi et al., 2006). After acute and chronic exposures, it causes a variety of adverse health effects to humans such as dermal changes, respiratory, pulmonary, cardiovascular, gastrointestinal, hematological hepatic, renal, neurological, developmental reproductive, immunologic, genotoxic, mutagenic, and carcinogenic effects (Mandal and Suzuki, 2002).

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