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# Analysis of Selected Metallic Impurities in Soft Drinks Marketed in Chittagong, Bangladesh

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**Abstract**

A total of 18 non-canned soft drinks and 12 canned soft drinks of different brands were collected from markets in Chittagong City of Bangladesh. It was found that, lead concentrations were significantly low in non-canned soft drinks. The highest level of lead content was obtained 0.016 $mgL^{-1}$. The content of lead in non-canned soft drinks was found in the range from 0.005 $mgL^{-1}$ to 0.016 $mgL^{-1}$. Lead concentrations in non-canned soft drinks were found below the maximum allowed limit for lead. Among all non-canned soft drinks, chromium was present in 11 samples. The highest concentration of chromium was found 0.018 $mgL^{-1}$. The concentrations of chromium in non-canned soft drinks were in the range from 0.006 $mgL^{-1}$ to 0.018 $mgL^{-1}$. Lead was found in 7 canned soft drinks. The lead concentration was in the interval from 0.006 $mgL^{-1}$ to 0.017 $mgL^{-1}$. The highest level of lead was found 0.017 $mgL^{-1}$. Chromium was found in 8 canned soft drinks. Concentration of chromium was in the range from 0.007 $mgL^{-1}$ to 0.019 $mgL^{-1}$ in canned soft drinks. The maximum concentration of chromium was found 0.019 $mgL^{-1}$ in canned soft drinks.

**Key words:** Analysis, Chromium, Drinks, Heavy metal, Lead

## 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). They are frequently flavored and colored and the principal component being water which is needed for hydration. Soft drinks are commonly consumed by both the young and older members of the Bangladeshi society to quench thirst, to enjoy social and religious settings and to taste beverage. Manufacturers of soft drinks require special attention to the purity and uniformity of ingredients, raw materials, sources of water and packaging material which are actually the sources of impurities in the drinks. The presence of metallic impurities in soft drinks can constitute health hazards to the public (Onianwa *et al*., 1999; Bakare-Odunola, 2005). Environmental pollution is the main cause of heavy metal 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 (Demırozu and Saldaml, 2002). As a result of the soil, atmosphere, underground and surface water pollution, our foods and beverages are getting contaminated with heavy metals (Krejpcıo *et al*., 2005). Due to the high toxicity of heavy metals (lead and cadmium), it is of public health interest that these metals are needs to quantified in commercially available soft drinks. Nickel is a compound that occurs in the environment only at very low levels. Foodstuffs naturally contain small amounts of nickel. Chocolate and fats are known to contain severely high quantities (Wilson, 2009). Toxicity of nickel has the following consequences: higher chances of development of lung cancer, nose cancer, larynx cancer and prostate cancer, sickness and dizziness after exposure to nickel gas, lung embolism, respiratory failure, birth defects, asthma, chronic bronchitis and allergic reactions (Kasprzak *et al*., 2003). Food is the main source of chromium intake by man and it is fairly and evenly distributed throughout the various food groups but highest concentrations of chromium are found in meat, fish, fruit and sugar groups. Potable water, fruit juices and soft drinks are some of the most widespread beverages in the habitual diet and they can contribute to chromium dietary intake. Chromium poisoning can be acute or chronic and death in acute chromium poisoning is usually due to uraemia (Maduabuchi *et al*., 2006). This research will investigate the exposure to heavy metals in the average diet in Bangladesh, as well levels of contaminations in commercially available soft drinks in Chittagong, Bangladesh. This will be done through the total diet study (TDS) approach. This will provide information on the dietary exposure to heavy metal contaminants, on its potential health implications as well as the potential sources of contamination and recommendations for action. Research findings may help provide the necessary evidence to mobilize support for implementing national policies that commit the Government to reducing heavy metal contamination of food. Hence the study was carried out to detect the presence of heavy metals (lead and chromium) in soft drinks commercially available in Bangladesh and to estimate the level of selected heavy metals (lead and chromium) in soft drinks commercially available in Bangladesh. Keeping the above views in maid the present work was undertaken to analysis some selected metallic impurities in soft drinks marketed in Chittagong, Bangladesh.

## Materials and Methods

### *Sample collection*

Most of all brands canned and non-canned soft drinks (carbonated drinks) available in Chittagong, Bangladesh were collected for this analysis.

### *Sample preparation*

Soft drinks were prepared by Acid Digestion method which is described in the literature (Bader, 2011). In general, nitric acid is used as oxidant alone or in combination with other acids (e.g., sulfuric and hydrochloric acids) or sometimes with hydrogen peroxide (Bock 1979; Barbosa *et al*., 2004; Nobrega *et al*., 2006). In addition, hydrofluoric acid can be used in combination with nitric acid for the total decomposition of silica containing organic matrices (CAC, 2005). Nitric acid is popular because of its chemical compatibility, oxidizing ability, availability, purity, and low cost (CAC, 2008). Determination of toxic metal ions concentration were carried out using the atomic absorption spectrophotometry (AAS) Analytikjena, ZEEnit700P, Germany.

### *Analytical methods and instrumentation*

Lead and chromium in soft drinks were determined according to previously described methods (Krejpcio *et al*., 2005; Maduabuchı *et al*., 2006). The samples were analyzed in a laboratory with a quality assurance schemes by using "Analytikjena Atomic Absorption Spectrophotometer, model: ZEEnit700P, Germany".

### *Measurement of different variables*

Exposure estimates have compared to health-based toxicological reference values (e.g. heavy metals have compared with acceptable daily intakes ADI).

### *Data analysis*

The concentration of lead and chromium in soft drinks were determined by using ASpect LS 1.2.0.0, Analytik Jena AG 2011-2012 system software. Statistical analysis was performed by using SPSS statistical software of version 14. All values were expressed as mean ± standard error of mean (SEM).

## Results and Discussion

Atomic absorption spectrophotometer (AAS) was calibrated to ensure the accuracy of the AAS and to establish that results of the determination proper were true and reliable. Standards with the concentration of lead at 0.40 ppm, 0.80 ppm, and 1.20 ppm respectively, were set for the calibration of the AAS. The AAS was also calibrated with chromium at concentration of 5 ppb, 10 ppb ppm, and 15 ppb respectively. The calibration curve of well prepared standards and an accurate AAS should present as a linear curve. The data on the calibration for lead and chromium are seen in Figures 1 and 2 respectively. Lead and chromium contents were determined in 18 non-canned and 12 canned soft drinks collected from Chittagong City of Bangladesh. The results of non-canned soft drinks are given in Table 1. Among all non-canned soft drinks lead was present in 8 samples. It was found that, lead concentrations were significantly low in non-canned soft drinks. The highest level of lead content was obtained 0.016 $mgL^{-1}$. The content of lead in non-canned soft drinks was found in the range from 0.005 $mg^{-1}$ to 0.016 $mgL^{-1}$. Lead concentrations in non-canned soft drinks were found below the maximum allowed limit for lead. Among all non-canned soft drinks chromium was present in 11 samples. The highest concentration of chromium was found 0.018 $mgL^{-1}$. The concentrations of chromium in non-canned soft drinks were in the range from 0.006 $mgL^{-1}$ to 0.018 $mgL^{-1}$.

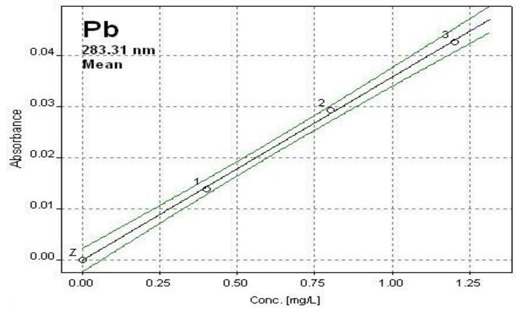


**Fig. 1.** Lead calibration curve

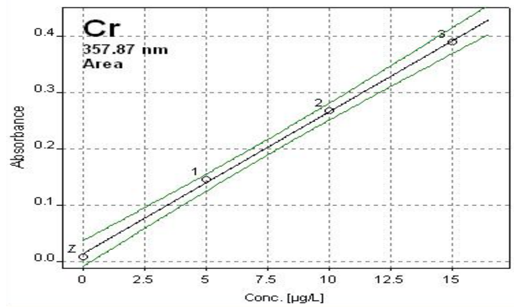


**Fig. 2.** Chromium calibration Curve

**Table 1.** Concentration of Lead and chromium in non-canned soft drinks

| Sample no. | Concentration in $mg^{-1}$ | |
|---|---|---|
| | **Lead** (mean ± SEM) | **Chromium** (mean ± SEM) |
| S-1 | 0.009 ± 0.0022 | 0.007 ± 0.0052 |
| S-2 | ND | 0.008 ± 0.0006 |
| S-3 | 0.008 ± 0.0012 | 0.006 ± 0.0032 |
| S-4 | 0.014 ± 0.0015 | ND |
| S-5 | ND | ND |
| S-6 | ND | 0.012 ± 0.0006 |
| S-7 | ND | 0.014 ± 0.0008 |
| S-8 | 0.010 ± 0.0022 | ND |
| S-9 | 0.007 ± 0.0005 | 0.008 ± 0.0005 |
| S-10 | ND | ND |
| S-11 | ND | ND |
| S-12 | ND | 0.018 ± 0.0011 |
| S-13 | 0.016 ± 0.0042 | 0.009 ± 0.0005 |
| S-14 | ND | ND |
| S-15 | ND | 0.006 ± 0.0009 |
| S-16 | 0.005 ± 0.0012 | ND |
| S-17 | 0.008 ± 0.0032 | 0.010 ± 0.0003 |
| S-18 | ND | 0.011 ± 0.0010 |

ND = Not detectable

The concentration of lead and chromium in canned soft drinks are given in Table 2. Lead was found in 7 canned soft drinks. The lead concentration was in the interval from 0.006 $mgL^{-1}$ to 0.017 $mgL^{-1}$. The highest level of lead was found 0.017 $mgL^{-1}$. Chromium was found in 8 canned soft drinks. Concentration of chromium was in the range from 0.007 $mgL^{-1}$ to 0.019 $mgL^{-1}$ in canned soft drinks. The maximum concentration of chromium was found 0.019 $mgL^{-1}$ in canned soft drinks.

**Table 2:** Concentration of Lead and chromium in canned soft drinks

| Sample no. | Concentration in $mg^{-1}$ | |
|---|---|---|
| | **Lead** (mean ± SEM) | **Chromium** (mean ± SEM) |
| S-1 | 0.007 ± 0.0004 | 0.009 ± 0.0008 |
| S-2 | 0.015 ± 0.0008 | 0.019 ± 0.0005 |
| S-3 | 0.006 ± 0.0003 | ND |
| S-4 | ND | 0.008 ± 0.0005 |
| S-5 | 0.008 ± 0.0008 | 0.010 ± 0.0014 |
| S-6 | 0.016 ± 0.0002 | ND |
| S-7 | ND | 0.014 ± 0.0008 |
| S-8 | ND | ND |
| S-9 | 0.006 ± 0.0004 | ND |
| S-10 | ND | 0.011 ± 0.0018 |
| S-11 | ND | 0.007 ± 0.0006 |
| S-12 | 0.017 ± 0.0005 | 0.009 ± 0.0005 |

ND = Not detectable

The maximum allowable limit of lead according to Codex alimentarius is 0.02 $mgL^{-1}$ for the ready-to-use product (CAC, 2005). In this study, the lead content in all of the samples was found under maximum permeable limit. The maximum concentration of lead in non-canned and canned soft drinks was found 0.017 $mgL^{-1}$ which is below the safe limit for lead in ready-to-use product. The Codex Alimentarius Committee considered the level of chromium is 0.05 $mgL^{-1}$ for water and health-related certain substances (CAC, 2008). The highest concentration of chromium in non-canned and canned soft drinks was found 0.019 $mgL^{-1}$ which is below the safe limit for chromium in water and health-related certain substances. In several countries, similar studies were previously reported concerning heavy metals as is the case in the current study (Krejpcio *et al.*, 2005) reported lead as 0.020–0.46 $mgL^{-1}$ in a total of 66 fruit juice samples examined in Poland. These lead levels in fruit juice samples were found to high in Krejpclo *et al.*, (2005), those found in our research also. Maduabuchi *et al.* (2006) reported lead levels were 0.002–0.0073 $mgL^{-1}$ in canned drinks and 0.092 $mg^{-1}$ in non-canned drinks. These lead levels were higher than those in our research. Onianwa *et al.* (2001) reported lead level as 0.04 ± 0.01 ppm in carbonated soft drinks in Nigeria. At the same time, they reported lead level of 0.06 ± 0.08 ppm in fruit juice (Onianwa *et al.*, 2001). These results were higher than those to ours. The research performed in England revealed that the heavy metal levels in the non-alcoholic beverage samples were within the standard limit. In this study lead was determined as 0.02–0.05 $mgkg^{-1}$ in non-alcoholic beverage samples from totally 100 samples (Maff, 1998). These lead contamination rates in the samples were found to be higher than were our results.

The chromium levels observed in our study is lower than the chromium levels reported in a Spanish study (Garcia *et al.*, 1999). Chromium is considered to be essential for the maintenance of lipid, protein and glucose metabolism. However, chromium supplements are becoming increasingly popular. In a double-blind randomized placebo-controlled clinical trial in a Chinese population with type 2 diabetes mellitus, supplementation with 1000 μg of chromium led to a fall in the glycosylated hemoglobin level by 2%. Previously, it was thought that toxic effects of chromium are seldom seen; recently however, the safety of one of the dosage forms of chromium (chromium picolinate) has been questioned. It is important to be aware that individual patients with type 2 diabetes mellitus might have increased risk of hypoglycemic episodes when taking chromium supplements as self-medication (Kleefstra *et al*., 2004). This raises concern for persons who may potentially increase their chromium levels to a toxic level from frequently but low-level intake. Despite the popular opinion on increasing chromium intake as one of the essential elements, consumers of soft drinks may be exposed to higher levels considering the relative contribution of chromium to the diet by soft drink beverages. Accumulation of chromium in the body can cause damage to the liver, kidney, nose, lungs; and possible asthma attack (Kleefstra *et al*., 2004).

## Conclusions

The purpose of this study was to focus concentration of selected metals in non-canned and canned soft drinks. The results of this study showed relatively higher concentration of heavy metal in canned soft drinks than in non-canned soft drinks. Concentration of lead and chromium was observed within maximum limit both in non-canned and canned soft drinks. Comparing results of the present study with those of other studies revealed similar levels of metals in non-canned and canned soft drinks investigated in the present study. However, the number of analyzed heavy metals was limited in our study due to small financial support. Further studies are necessary to evaluate the contents of ‘‘essential’’ and ‘‘toxic’’ heavy metals on a greater number of samples to confirm the absence of possible toxicological risks.

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