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Detection of Heavy Metals in Some Commercial Brands of Noodles

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Abstract:

With growing international trade, food safety has emerged as an important global issue. In the context of current global challenges in food safety and security, the study was conducted to assess heavy metal concentrations (lead [Pb], cadmium [Cd], Arsenic [As], nickel [Ni] and tin [Sn]) in some commercial brands of Bangladeshi noodles by using an atomic absorption spectrophotometry (AAS) and the stage of sample preparation prior to measurement by using a microwave digestion system in a closed vessel. The magnitude of heavy metals as lead (1.17-1.67 mg/kg), cadmium (0.53-0.82 mg/kg), nickel (0.27-0.43 mg/kg), arsenic (0.17-0.41 mg/kg) and tin (2.60-3.72 mg/kg) contamination were found in noodles samples but all the monitored metals were within the safe limit approved by BSTI for noodles. Although heavy metals in noodles do not pose any immediate risk to human health so far, a yearly monitoring program for heavy metals in commercial brands of noodles is necessity.

Key words: lead (Pb); Cadmium (Cd); Arsenic (As); Nickel (Ni); Tin (Sn); Noodles

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1. Introduction

Noodles are one of the most important foods in Asian cuisine. Approximately 40% of the total wheat flour consumed is in the form of noodles in Asia. In addition to the wheat flour, noodles are made from simple ingredients like water and salt and contain carbohydrates, protein and small amounts of fatty acids [1].

In Bangladesh the market for noodles has growing by more than 10 percent per year for the last couple of years, which encourages existing operators to expand operations and attracts new entrants. A decade or more ago, demand for noodles was low. Initially, popularizing the food item was a challenge as consumers were not habituated to the taste. But now the market is growing due to the quality of our product as well as increased communication among consumers. It is tasty, nutritious and easy to prepare within a short time. Noodles are now consumed by many health conscious people, especially job holders, as an afternoon meal because it helps in saving time [2].

Heavy metals are potential environmental contaminants with the capability of causing human health problems if present to excess in the food we eat. They are given special attention throughout the world due to their toxic effects even at very low concentrations. Several cases of human disease, disorders, malfunction and malformation of organs due to metal toxicity have been. Legumes, cereals and cereal products are essential foodstuffs for human diet. Many studies pointed out that legumes and cereals contaminated with different levels of heavy metals [3].

Studies on heavy metals are important from public point of view, where the attention has been drawn to the necessity of measuring the accumulation of heavy metals, particularly those metals which pose serious health hazards to human (e.g. Cd and Pb). Human exposure to heavy metals has risen

dramatically in the last 50 years, however, as a result of an exponential increase in the use of heavy metals industrial processes and products. Today chronic exposure comes from chemical residues in raw foods and processed foods. In today's industrial society, there is no escaping exposure to toxic chemicals and metals [4].

Exposure of consumers to heavy metals and related health risks are usually expressed as percentage intake of Provisional Tolerable Weekly Intake (PWTI), a reference value established by WHO (1992) [5] and WHO(1995) [6]. According to this, the weekly intake of metals from all sources should not exceed 0.05 and 0.075 mg.kg-1 body weight for lead and cadmium, respectively. Cadmium and lead are among the most abundant heavy metals and are particularly toxic. Cadmium exposure may cause kidney damage and/or skeletal damage. Airborne lead can be deposited on soil, water and plants thus reaching human via the food chain. Lead is accumulated in the skeleton and cause renal tubular damage and may also give rise to kidney damage [5], [6]. International Agency for Research on Cancer (IARC) classified cadmium and lead as human carcinogen [3], [7].

However, to the best of our knowledge, there is invariably insignificant information in literature performed on detection of heavy metal in commercial brands of Bangladeshi noodles. Hence, the study is essential to meet a void in research. It is important to detect the amount of heavy metals in commercial brands noodles in order to evaluate the possible risk of noodles consumption. So the study was undertaken to determine the levels of heavy metals like lead (Pb), cadmium (Cd), Arsenic (As), nickel (Ni) and tin (Sn) in the commercial brands noodles available in Bangladeshi market. These concentrations were then compared against the recommended maximum levels according to Bangladesh Standards and Testing Institution (BSTI) (2001) standard allowed in noodles.

2. Materials and Methods

2.1. Sampling

Noodles samples sold as four commercial branded noodles (coded as A, B, C and D) and one local non-branded noodles (coded as E) were purchased from various markets in Mymensingh, Bangladesh. Samples were coded to overcome the sampling biasness.

2.2. Sample preparation

Noodles samples were taken randomly from the composite sample and were processed for analysis by the dry-ashing method. Wet solid samples were first dried in oven at 105°C for 24 hrs and then ground while solid samples were ground directly. The ground solid samples (5g each) were placed in crucibles and few drops of concentrated nitric acid were added to the solid as an ashing aid. Dry-ashing process was carried out in a muffle furnace by stepwise increase of the temperature up to 550°C and then left to ash at this temperature for 4 hrs [8]. The ash was left to cool and then rinsed with 1M nitric acid. The ash suspension was filtered and the filtrate made up to the volume of 25 ml with 1M nitric acid.

2.3. Spectroscopic analysis

The sample solutions were subsequently analyzed for heavy metal contents, as dry weight basis, using an atomic absorption spectrometer. Measurements were made using the hollow cathode lamps for Pb, Cd, Ni, As and Sn. Pb, Cd and Ni were determined by graphite furnace atomic absorption spectroscopy (GFAAS) at 283.31 nm, 228.86 nm and 232.03 nm wavelength respectively with oxidizing Air-acetylene flame. Sn was determined by AAS at 235.5 nm wavelength with oxidizing N_2O-C_2H_2 flame. Hydride generation was used for measuring the levels of arsenic at wavelengths of 193.7nm. Working solutions were prepared by dilution just before the use of

standard solutions for atomic absorption spectroscopy. For the determination, three solutions were prepared for each sample and three separate readings were made for each solution. The means of these figures were used to calculate the concentrations.

2.4. Quality assurance

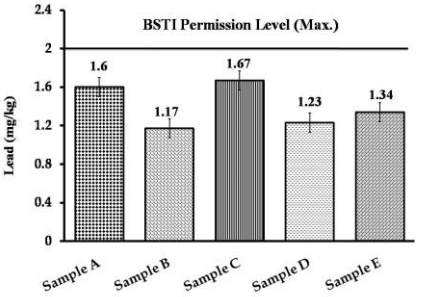
Appropriate quality assurance procedures and precautions were carried out to ensure reliability of the results. Samples were generally carefully handled to avoid contamination. Glassware was properly cleaned, and the reagents were of analytical grade. Double distilled deionized water was used throughout the study. Reagents blank determinations were used to correct the instrument readings. A recovery study of the analytical procedure was carried out by spiking and homogenizing several already analyzed samples with varied amounts of standard solutions of the metals. The spiked samples were processed for the analysis by the dry ashing method and reanalyzed as described above.

3. Results and Discussions

3.1. Concentration of Heavy Metal in Noodles

3.1.1. Concentration of Lead (Pb) in Noodles

Concentration of lead in four commercial brands of noodles and one non-brand of noodles were estimated and the results are illustrated in Figure 1.



Sample A, B, C and D= Commercial Branded Noodles

Sample E= Non-Branded Noodles

Figure 1. Concentration of lead (Pb) in noodles

Concentration of lead in four commercial brands of noodles and one non-branded noodle was found in the range 1.17-1.67 mg/kg. The higher lead concentration was obtained in sample C (1.67 mg/kg) as presented Figure 1. Lead concentration was obtained to be low in sample B (1.17 mg/kg). No previous studies were found of Pb concentration in commercial brands of noodles.

The possible sources of Pb are from raw ingredients used in noodles. Wheat flour is the main raw materials for noodles. Maleki and Zarasvand (2008) reported that the environment for conventional agriculture was contaminated by Pb. The possible sources of Pb in wheat include irrigation with contaminated water, application of fertilizer and metal based pesticides, industrial emissions, transportation as well as method of harvesting and storage [9]. According to Auroville Innovative Urban Management final report (2003), Lead has been processed in many ways, e.g. for water pipes and containers. The main sources of lead pollution in the environment are: Industrial production processes and their emissions, road traffic with leaded petrol, the smoke and dust emissions of coal and gas-fired power stations, the laying of lead sheets by roofers as well as the use of paints and anti-rust agents [10].

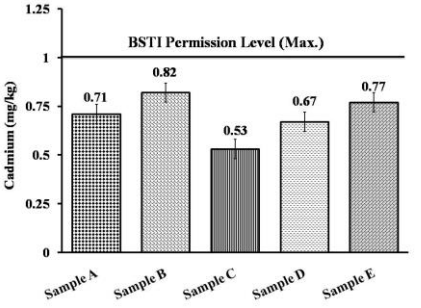
According to WHO (1995), the weekly intake of metals from all sources should not exceed 0.05 mg.kg-1 body weight for lead. Airborne lead can be deposited on soil, water and plants thus reaching human via the food chain. Lead is accumulated in the skeleton and cause renal tubular damage and may also give rise to kidney damage [6]. Lokeshappa *et al.* (2012) expressed that lead will cause nervous disorder, high blood pressure and muscle pain [11].

According to BSTI (2001) standard and WHO (1995) standard, the maximum permissible level for Pb was 2 mg/kg [12] and 5 mg/kg [6] respectively. From figure 1, concentration of lead in commercial brands noodles and non- branded noodle was lower than maximum permission limits.

3.1.2. Concentration of Cadmium (Cd) in Noodles

No objection level of cadmium was observed in commercial brands noodles and non-branded noodle used in this research. The cadmium contents of all samples are demonstrated in Figure 2.

As shown in figure 2, the cadmium values varied between 0.53 mg/kg and 0.82 mg/kg in commercial brands of noodles samples. The higher concentration of Cd was found in sample B (0.82 mg/kg) followed by sample E (0.77 mg/kg), A (0.71 mg/kg), D (0.67 mg/kg) and C (0.53 mg/kg). No previous studies were found of Cd concentration in commercial brands of noodles.



Sample A, B, C and D= Commercial Branded Noodles

Sample E= Non-Branded Noodles

Figure 2. Concentration of cadmium (Cd) in noodles

According to WHO (1992), the weekly intake of metals from all sources should not exceed 0.075 mg.kg-1 body weight for cadmium. Cadmium is among the most abundant heavy metals and is particularly toxic. The excessive content of this metal in food is associated with etiology of a number of diseases. Cadmium compounds are used as color pigment. It is also present as a pollutant in phosphate fertilizers that are used in cereals grains like wheat, major raw materials for noodles [5]. Jarup *et al.* (1998) pointed out that cadmium is present in most foodstuffs, but concentrations vary greatly. Cadmium exposure may cause kidney damage and/or skeletal damage [13].

According to BSTI (2001) standard, the maximum permissible level for Cd was 1 mg/kg [12]. Comparing the result with the heavy metal limitation set by BSTI, none of the noodles samples exceeded the permissible level.

3.1.3. Concentration of Nickel (Ni) in Noodles

Concentration of nickel in four commercial brands of noodles and one non-branded noodle were evaluated and the results are illustrated in Figure 3.

The nickel content of commercial brands of noodles and non-branded noodle was found in this study ranged from 0.27-0.43 mg/kg. The higher nickel content was found in sample C (0.43 mg/kg) followed by E (0.35 mg/kg), B (0.35 mg/kg), A (0.33 mg/kg) and D (0.27 mg/kg). No previous studies were found of Ni concentration in commercial brands of noodles.

According to BSTI (2001) standard, the maximum permissible level for Ni is 1 mg/kg [12]. From figure 3, concentration of Ni in commercial brands of noodles and non-branded noodle was lower than maximum permission limits.

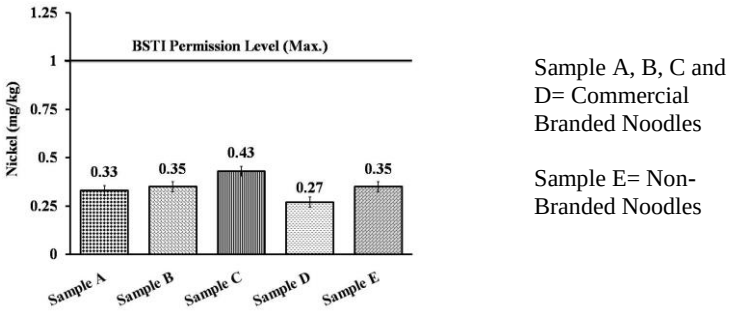
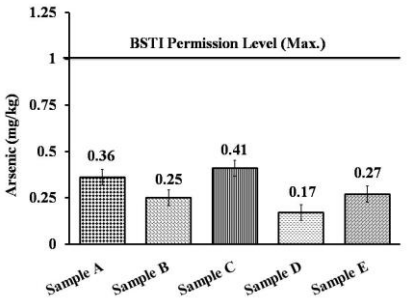


Figure 3. Concentration of nickel (Ni) in noodles

3.1.4. Concentration of Arsenic (As) in Noodles

Concentration of As in four commercial brands of noodles and one non-branded noodle were estimated and the results are illustrated in Figure 4.

Arsenic is usually regarded as a hazardous heavy metal even though it is actually a semi-metal. As can be seen from Figure 4, arsenic values varying between 0.17 mg/kg and 0.41 mg/kg in four commercial brands noodles and one non-branded noodle where the higher concentration of arsenic was found in sample C (0.41 mg/kg) followed by sample A (0.36 mg/kg), E (0.27 mg/kg), B (0.25 mg/kg) and D (0.17 mg/kg). No previous studies were found of Arsenic concentration in commercial brand of noodles.



Sample A, B, C and D= Commercial Branded Noodles

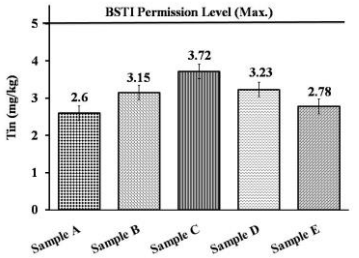
Sample E= Non-Branded Noodles

Figure 4. Concentration of arsenic (As) in noodles

According to BSTI (2001) standard, the maximum permissible level for Arsenic was 1 mg/kg [12]. From Figure 4, none of the noodles samples exceeded the maximum permissible limit.

3.1.5. Concentration of Tin (Sn) in Noodles

Concentration of tin (Sn) in four commercial brands of noodles and one non-brand of noodle were estimated and the results are illustrated in Figure 5.



Sample A, B, C and D= Commercial Branded Noodles

Sample E= Non Branded Noodles

Figure 5. Concentration of tin (Sn) in noodles

The Sn content of commercial branded noodles and non-branded noodle was found in this study ranged from 2.60-3.72 mg/kg. The higher Sn content was found in sample C (3.72 mg/kg) followed by D (3.23 mg/kg), B (3.15 mg/kg), E (2.78 mg/kg) and A (2.60 mg/kg). No previous studies were found of Sn concentration in commercial brands of noodles.

A major source of tin contamination is tin plate, which is used for making containers for all types of processed foods. A small quantity of metal might be added when food will be contacted in aluminum utensils.

According to BSTI (2001) standard, the maximum permissible level for Sn is 5 mg/kg [12]. From figure 5, concentration of Sn in commercial brands of noodles and non-branded noodle was lower than maximum permission limits.

3.2. Possible Contamination Sources during Noodles Production

The possible contamination sources along the processing line can schematically be represented as in Figure 6.

The main ingredient for noodles is wheat flour. From this study, it was found that noodles can be contaminated with some heavy metal within permission limits. Contamination can be occurred from wheat flour because it may contain heavy metal such as lead, cadmium, nickel and arsenic.

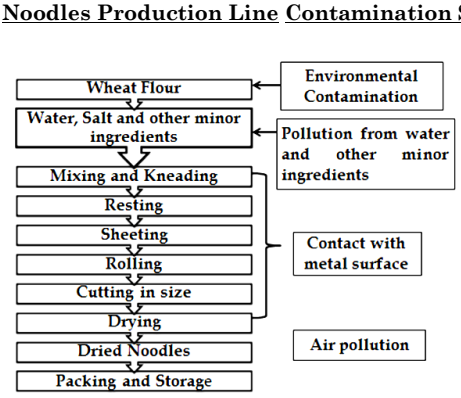


Figure 6. Possible contamination sources during noodles production

The possible sources of heavy metals in wheat include irrigation with contaminated water, application of fertilizer and metal based pesticides, industrial emissions, transportation as well as method of harvesting, storage, industrial production processes and their emissions, road traffic with leaded petrol, the smoke and dust emissions of coal and gas-fired power stations as well as the use of paints and anti-rust agents. Water and other minor ingredients may contain heavy metals such as arsenic, lead, cadmium etc. Water may also contain microbial contamination to noodles. During mixing, kneading, resting, sheeting, rolling and cutting, the noodles dough has direct contact with metal surface, thus metal can be mixed with noodles dough. Air may contain some heavy metals because of air pollution. Air is also a possible source of heavy metals in noodles.

4. Conclusions

Heavy metals are environmental hazardous and many developed and developing countries have been continuing to monitor the trends of its concentrations in foods. But maximum residue limits (MRL) for heavy metals in processed foods are currently not in force in most countries. This study shows that there has been some heavy metals contamination in commercial brands of noodles but safe levels of the heavy metals were analyzed and hence may have no adverse effects normally associated with heavy metal toxicity on people who patronize these products for their health needs. Although heavy metals in noodles do not pose any immediate risk to human health so far, a yearly monitoring program for heavy metals in commercial brands of noodles is necessity.

5. Acknowledgement

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