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Short communication

Determination of heavy metal content in baby food samples with the method of ICP-MS

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Introduction

With the development of industry and technology, environmental pollution is increasing, which in turn has a negative effect on food quality. The Rulebook on health safety of dietary products in the Republic of Serbia (The Rulebook on health safety of dietary products, 2022) prescribes the permitted concentrations of foreign substances in food, which can be found due to the use of chemicals while cultivation or production. Heavy metals are of particular importance in factory-made baby food. Lead, cadmium, mercury and arsenic are considered non-essential heavy metals and pose a danger to the organism if they are ingested in concentrations higher than allowed. Lead has the ability to strongly bind to sulfhydryl groups of proteins, competitively binds to Ca^{2+}, and it contributes to the formation of reactive oxygen species *in vivo*, which causes a decrease in internal antioxidant defense and disorders in the exchange of electrolyte ions across cell membranes. Lead also inhibits certain phases in heme synthesis. Cadmium is classified as a carcinogen by the International Agency for Research on Cancer and belongs to the 1st group of carcinogens. Cadmium affects the cell development cycle, proliferation, differentiation, DNA reparation, replication and apoptosis, leading to promotion of cancer in tissues. The aim of our study was to check the contents of heavy metals (As, Pb, Hg, Cd) in random samples of children's food found on the market of the Republic of Serbia.

Materials and methods

ICP-MS was used to determine the content of heavy metals in various samples of baby food (flour, instant flakes, porridges, purees, juices), as well as in row materials used for the local baby food production. The content of heavy metals lead, cadmium, mercury and arsenic was determined in 7 samples of different types of flour, as well as in 14 baby food samples in total, produced by 7 different manufacturers. The results were compared against the allowed limits from the Rulebook on health safety of dietary products.

The measurement is performed in Realab laboratory, using the iCAP RQ ICP-MS instrument. Inductively coupled plasma mass spectrometer (ICP-MS) is an analytical instrument that combines ICP technology and mass spectrometry. ICP uses the powerful high-frequency radio frequency signal applied to the inductor coil to form high-temperature plasma inside the coil, and is pushed by the gas to ensure the balance and continuous ionization of the plasma. In ICP-MS, ICP acts as an ion source. The high temperature plasma makes most of the elements in the sample ionize an electron to form a monovalent positive ion. Mass spectrometry is a mass screening and analyzer that detects the intensity of a certain ion by selecting ions with different mass-to-nucleus ratios (m/z), and then analyzes and calculates the intensity of a certain element.

Results and discussion

The content of heavy metals lead, cadmium, mercury and arsenic was determined in 7 samples of different types of flour. The lead content in the analyzed flour samples did not exceed the allowed limit of 0.08 mg/kg according to the official requirements. One sample of rice flour contained the boundary value for cadmium of 0.02 mg/kg, while cadmium content in other samples was below the allowed limit. The maximal allowed value of

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mercury concentration is 0.005 mg/kg, what was complied in each sample. The permissible concentration for arsenic is 0.08 mg/kg, and the values above the permitted level were found in two types of rice flour samples (0.109 mg/kg and 0.138 mg/kg), corresponding to relative deviations of 126.2% and 162.5%, respectively. In other samples, the values were within the prescribed limits.

The analyses of 6 samples of different types of porridge for children (spaghetti Bolognese, carrot and broccoli, apple and banana, apple and plum, apricot, apple) have shown that in all samples lead was below the permissible value (0.08 mg/kg). The cadmium content did not exceed the prescribed value of 0.02 mg/kg, while the concentration of mercury was also below the prescribed value of 0.005 mg/kg. The concentration of arsenic was found to be below the allowed limit of 0.08 mg/kg.

Eight types of analyzed instant flakes (4 chocolate and one fruit, caramel and biscuit) had a content of lead, cadmium, mercury and arsenic below the permitted values prescribed by the Rulebook on health safety of dietary products. Analysis of 3 different types of fruit puree yielded results showed that the lead content in all samples was less than 0.015 mg/kg, cadmium and mercury less than 0.005 mg/kg, arsenic less than 0.01 mg/kg, which are values below the prescribed limits.

In 4 samples of fruit juice from different types of fruit which were analyzed, it was shown that the concentration of lead in all samples was below 0.008 mg/kg, cadmium and mercury below 0.003 mg/kg and arsenic below 0.005 mg/kg, which is for each measured heavy metal (As, Pb, Hg, Cd) below the prescribed values.

Conclusion

Contaminated food is one of the most important sources of exposure to heavy metals. Although most of the obtained results were within the allowed limits, continuous monitoring of children's food in terms of heavy metal content is necessary due to increased sensitivity in children to exposure of heavy metals, compared to the adults.

Based on the results obtained by testing 14 samples of baby food, it was found that all samples have a content of lead, cadmium, mercury and arsenic below the permitted values prescribed by the Rulebook on health safety of dietary products. Analyzing the raw materials used in the production of baby food, it was found that in two samples of rice flour the concentration of arsenic was 0.109 mg/kg and 0.138 mg/kg, respectively, that is 126.2% and 162.5% above the maximal allowed concentrations recommended in the Rulebook on health safety of dietary products in the Republic of Serbia.

Although the number of samples is small to draw statistically relevant conclusions (i.e. < 10) on the incidence of baby food contamination with heavy metals, it is alarming that deviations from the recommended limits where significant (above 100% in relative deviation).

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