Monitoring and exposure of the population of the Slovak Republic to heavy metals

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The occurrence of the contaminants in various food commodities is considered one of the main factors influencing food quality and safety. In countries with the effective legislative framework and the control activities, the health risk is lower. In the Slovak Republic this domain has been in the permanent focus of the Agricultural Sector since 1986, when the national control system has been introduced. Later, in 1991 Partial Monitoring System (PMS) "Food and Feed Contamination" was implemented. One of its 3 subsystems is Market Basket Monitoring. The objective of Market Basket Monitoring (MBM) is to gain actual information on foodstuffs contamination directly in the network of consumers; this will be subsequently applied as data source for national nutrition policy and assessment of the dietary exposure of population to contaminants. In the Slovak Republic, Market Basket Monitoring has been run since 1993. The selection of the localities, observed within the Market Basket Monitoring was the subject of the separated project, since in the same localities the other surveys would be run subsequently. The selected localities represent at least 20 000 inhabitants and various settlement types (rural/urban i.e. village, city, etc.). Within the Market Basket Monitoring, staple food commodities as well as the most frequently used foodstuffs are collected, considering the dietary habits of the Slovak Republic population and data on consumption of the HBS (Household Budget Survey) and FBS (Food Balance Sheets) survey of the Statistical Office of the Slovak Republic. Market Basket Monitoring includes commodities which contribute with at least 0.5% to the statistically expressed consumption. Sampling of commodities for MBM is organized biannually (May, October). Stated types of food commodities are purchased from the retail network in the selected localities and prepared in accordance with Slovak Technical Standards by inspectors of the State Veterinary and Food Administration and Water Research Institute. The samples were analyzed for the occurrence of the following contaminants: heavy metals - As, Hg, Cd, Pb, Cr, Ni; pesticide residues, PCBs, nitrates, aflatoxines and residues of veterinary drugs. In general, during the period from 1993 to 2006, total of 9976 samples of foodstuffs (27 food commodities) and water, collected for the requirements of the Market Basket Monitoring were analyzed (152 362 analyses). Total of 425 samples (4.26%) were over-limited, mainly in case of nitrates and chemical elements content. As regards heavy metals, there was 150 over-limited samples.
(1.7%) out of 8782 samples analyzed on the heavy metals occurrence (52 681 analyzes). The highest frequency of the over-limited samples was found in case of nickel (64 samples), followed by chromium (51 samples) and cadmium (30 samples). In case of arsenic, there was 12 samples over-limited, and in case of lead - 10 samples. Only one sample had over-limited mercury content.

Analytical findings obtained for the MBM (mean values) can be utilized for the assessment of the dietary exposure, where the evaluated daily/weekly doses of observed contaminants ingested via food and beverages are calculated using the specific model of consumption for particular food commodities. For assessment of the dietary exposure of the average inhabitant we used the model of consumption, based on data from HBS survey of the Statistical Office of the Slovak Republic. Subsequently, the obtained exposure doses of assessed contaminant are compared to the respective limit value (Provisional tolerable weekly intake - PTWI) [4], defined by the international Joint Expert Committee on Food Additives and Contaminants (JECFA FAO/WHO). Within this paper, the assessment of the dietary exposure doses was done for: arsenic, mercury, cadmium and lead; for the assessment of their intake, the findings in commodities of the MBM (27 commodities) as well as the findings in commodities of the control system and other monitoring subsystems (66 additional commodities) were utilized. In case of chromium and nickel only provisional assessment of the dietary doses, based only on findings in the commodities of the MBM, was done.

**Arsenic:** The evaluation of the dietary exposure to arsenic was done for the period 1994-2005. According to data from 2005, the major contribution to dietary intake of total arsenic was from fish and fish products (25.31% of the overall daily intake). Also, these commodities had the highest findings. However, in fish and other sea food, the prevailing form of arsenic is less toxic organic form. In general, the estimated daily doses of total arsenic for the average inhabitant of the Slovak Republic in the period of observation ranged between 17.49 and 41.66 µg. Related to body weight (70 kg), the respective values would be 0.25 and 0.60 µg kg⁻¹ bw. These values showed several slight variations of the relatively stable trend during the period of observation. The maximum value of the exposure was calculated for the first year of the observation period. Since 2001 the trend has been in decrease. Since the exposure limit value for total arsenic has not been stated, the risk of total arsenic intake cannot be accurately evaluated, and in comparison to the PTWI value for more toxic inorganic form (15 µg kg⁻¹ bw per week) it would be overestimated (compared to this value the share of the values obtained in our survey would range from 11.7 to 27.8% PTWI.
**Mercury:** The highest levels of mercury were found in fish, mushrooms (which are considered as a commodity from the group of vegetables) and game. Assessment of mercury intake from the particular commodities (2004) suggests that the most significant sources of the exposure doses of mercury included fish and fish products which accounted for 20.4% of the overall weekly intake (0.166 µg.kg⁻¹ bw) followed by vegetables and vegetable products (12.1% of the weekly intake). In general, the evaluation of the dietary exposure to mercury suggested relatively low levels, with rather stable trend of values during the period of observation (1990-2004). Values of the weekly exposure dose ranged between 0.166 µg.kg⁻¹ bw per week in 2004 and 0.626 µg.kg⁻¹ bw per week in 1991 (mean mercury findings, HBS-based model of consumption); The PTWI value (5 µg.kg⁻¹ bw per week) was not exceeded, and weekly intake of mercury for the average inhabitant of the Slovak Republic ranged between 3.3% and 12.5% PTWI.

**Cadmium:** Exposure of the Slovak Republic population to cadmium from food and beverages was studied for the period from 1990 to 2004. According to the surveys from 2004, the highest findings were found in oily seeds yeast and gelatin; however, the most significant sources of cadmium were vegetables and vegetable products. The share of these products on the overall weekly intake was 22.4%. The share of bread was 20.17%. Generally, the assessed exposure levels were persistently low during the period of observation, with a moderately decreasing tendency especially for the past few years of the observation. The assessed weekly exposure doses of dietary cadmium based on mean values ranged between 0.932 (2004) and 2.6 (1992) µg.kg⁻¹ bw. Compared to the PTWI stated for cadmium (PTWI – 7 µg.kg⁻¹ bw per week) the respective values would be 13.31% PTWI and 36.8% PTWI. [1]

**Lead:** The highest levels of this element were found in meat and tea. Assessment of lead intake from the particular commodities (2002) suggests that the most significant sources of the exposure doses were beverages, which contributed to the overall weekly intake with 16.2%. In general, the estimation of dietary exposure of the average consumer to lead was done for the period 1986 – 2002 and the estimated levels were stable and low, with tendency of slight decrease in last years of the observation. Weekly exposure values ranged from 3.5 (2002) to 17.5 (1987) µg.kg⁻¹ bw per week. Compared to the PTWI value, stated for lead (25 µg.kg⁻¹ bw per week) the respective values would be 14 to 70% PTWI. [2]

**Chromium:** According to the recommended dietary allowances (RDA) daily intake dose stated for chromium is in range from 0.7 to 3 µg.kg⁻¹ bw. Daily intake of this element was assessed provisionally, from the results of the Market Basket Monitoring, obtained during period from 1993 to 2005. Low doses of the intake (calculated from mean values of the
findings) ranging between 0.32 (1995) and 1.9 (1999) µg.kg⁻¹ bw were calculated. The reported values for 6 (out of 13) years of the survey were below the lower limit of the RDA values for chromium. The trend of the obtained values was in increase from 1995 to 1999, followed by decrease down to 0.35 µg.kg⁻¹ bw in 2003. The daily intake of chromium in 2004 was 0.7 µg.kg⁻¹ bw and again in 2005 these doses reduced to 0.58 µg.kg⁻¹ bw. According to the results of the MBM from 2005, the highest levels of this element were found in edible vegetable oils, poultry, soft cheeses, meat products and smoked meat. The commodities, with the major contribution to the overall daily intake of chromium were potatoes, beer, flour, and fruit juices.

**Nickel:** Daily intake of nickel was assessed provisionally, from the results of the Market Basket Monitoring, obtained during period from 1993 to 2005, and results obtained during this period reported dietary doses (calculated from mean findings) ranging between 0.92 µg.kg⁻¹ bw (2003 and 2004) and 2.39 µg.kg⁻¹ bw (1999). For this element the tolerable daily intake (TDI) value of 5 µg.kg⁻¹ bw has been stated by WHO, and compared to this value, the obtained daily dietary doses of nickel ranged between 18.4 and 48% TDI. The trend of estimated doses was relatively stable, showing the slight decrease from 1999 to 2004, followed by increase of doses up to 1.75 µg.kg⁻¹ bw (35% TDI) in 2005. According to the results of the MBM from 2005, the highest concentrations of nickel were found in commodities such as lard, rice, soft cheeses and tomatoes. The commodities, with the major contribution to the overall daily intake of nickel were beer, potatoes, flour, and fruit juices.

**References:**