Health risk estimation of potentially toxic elements in complementary fruit-based food

Ivana D. Rasic Misić*, Snezana B. Tosić, Aleksandra N. Pavlović, Emilia T. Pecev-Marinkovic, Jelena M. Mrmosanin

University of Nis, Faculty of Science and Mathematics, Department of Chemistry, Vasegradska 33, PO. Box 224, 18 000 Nis, Serbia

* Corresponding author; e-mail: ivana.rasic@pmf.edu.rs

Abstract

The inductively coupled plasma emission spectrometric (ICP-OES) method was used for the simultaneous determination of ten elements (Zn, Fe, Cr, Cu, Mn, Ni, Al, Ba, Pb and Sr) in 23 samples of purees and juices. Potentially toxic elements can be harmful if present in food. Even essential and probably essential elements can be toxic if present in excessive amounts. Infants and toddlers are particularly vulnerable due to their smaller body size, developing brains and organ systems. The determination of mineral content in baby purees and juices is very important (for both manufacturers and consumers) due to their positive as well as negative impact on children’s health. Health risk assessment of potentially toxic elements on infants and toddlers was estimated by calculating the average daily dose (ADD), hazard quotient (HQ) and hazard index (HI). The values of HI < 1 for all analyzed fruit products suggest that none of the quantified potentially toxic elements may pose a health risk for selected groups of children. Health risk for lead was not estimated since EPA have not yet established the chronic oral reference dose (RfD) for this metal. Also, previous official provisional tolerable weekly intake (PTWI) value of 25 µg Pb/kg body weight/day was withdrawn. New PTWI value that would be considered health protective has not been possible yet to establish. However, the lead exposure was evaluated based on the size of daily consumption of sample with highest lead content and average toddlers body weight. The value of 2.02 µg Pb/kg body weight/day is in the lead exposure interval (1.1 – 3.10 µg Pb/kg body weight/day) estimated by EFCA.

Parameters for calculating ADD.

<table>
<thead>
<tr>
<th>Type of food</th>
<th>Young children</th>
<th>ED (years)</th>
<th>EF (days)</th>
<th>AT (years-days)</th>
<th>IR (per capita) g/kg bw/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruits</td>
<td>Infants</td>
<td>0.5</td>
<td>350</td>
<td>0.5·365</td>
<td>5.7</td>
</tr>
<tr>
<td></td>
<td>Toddlers</td>
<td>0.5</td>
<td>350</td>
<td>0.5·365</td>
<td>6.2</td>
</tr>
<tr>
<td>Juices</td>
<td>Toddlers</td>
<td>0.5</td>
<td>350</td>
<td>0.5·365</td>
<td>10</td>
</tr>
</tbody>
</table>

ADD = c ∙ IR ∙ EF ∙ ED / BW ∙ AT
HQ = ADD / RfD
ADD (total toddlers) = ADD (infants) + ADD(toddlers)

Average ADD values (mg/kg/day) of metals for infants and toddlers consuming fruit products (non-carcinogenic risk calculations).

Eлемент | ADD | Toddlers | ADDTotal | ADD Juices |
---------|-----|----------|----------|-----------|
Zn       | 7.98E-03 | 1.67E-02 | 1.15E-02 |
Fe       | 1.45E-02 | 3.03E-02 | 2.75E-02 |
Cr       | 9.40E-04 | 1.96E-03 | 2.11E-03 |
Cu       | 4.21E-03 | 8.79E-03 | 5.75E-03 |
Ni       | 7.93E-04 | 1.66E-03 | 1.53E-03 |
Sr       | 5.25E-03 | 1.10E-02 | 1.10E-02 |
B        | 1.39E-02 | 2.91E-02 | 1.84E-02 |
Al       | 4.61E-02 | 9.62E-02 | 5.90E-02 |
Ba       | 2.90E-03 | 6.05E-03 | 4.22E-03 |
Mn       | 6.17E-03 | 1.29E-02 | 4.99E-03 |
Pb       | 6.56E-05 | 1.37E-04 | 1.25E-03 |

ADDs for Zn, Fe, Cr, Cu, Mn, Ni, Al, Ba and Sr in both types of samples are lower than their RfDs.

Conclusion

HQ and HI values for both age groups of consumers were below 1. The results showed that none of the analyzed potentially toxic elements may pose a health risk for both infants and toddlers if consuming analyzed fruit purees. This data certainly does not diminish the obligation of the manufacturer to carefully select fruits through the application of quality control in each step of the production process.

Acknowledgements: This research was financially supported by the project of the Ministry of Education, Science and Technological Development of Republic of Serbia (Agreement No 451-03-9/2021-14/200124).