Fresh Fruits' Quality in View of their Heavy Metal Composition

M. Grembecka[1], A. Gallas-Chrulska[2], A. Pankowska[3], P. Szefer[4]

[1]Department of Food Sciences, Medical University of Gdańsk, Al. Gen. J. Hallera 107, PL 80-416 Gdańsk, Poland, **mgrembecka@amg.gda.pl**
[2]Department of Food Sciences, Medical University of Gdańsk, Al. Gen. J. Hallera 107, PL 80-416 Gdańsk, Poland
[3]Department of Food Sciences, Medical University of Gdańsk, Al. Gen. J. Hallera 107, PL 80-416 Gdańsk, Poland
[4]Department of Food Sciences, Medical University of Gdańsk, Al. Gen. J. Hallera 107, PL 80-416 Gdańsk, Poland, **pszef@amg.gda.pl**

Abstract

The aim of the study was to assess quality of different fresh fruits in view of their heavy metal composition. Moreover, the human exposure to heavy metals was assessed. The elements (Zn, Cu, Mn, Fe) concentrations in different kinds of fruits obtained at retail were analysed by flame atomic absorption spectrometry (F-AAS) using deuterium-background correction. Reliability of the procedure was checked by the analysis of the certified reference materials, i.e. Tea (NCS DC 73351) and Cabbage (IAEA-359). The findings concerning metal content in the analysed products differed significantly. The determined levels of Fe, Zn, Cu and Mn were in the range of 0,10 - 1,56, 0.02 - 0.52, 0.002 - 0.34 and 0.01 - 3.03 mg/100 g, respectively.

Key words: Heavy metals; fruits; AAS; RDA

Introduction

Similarly to vegetables, fruits composition varies significantly. Overall, fruits supply carotenoids, including those that form vitamin A, as well as vitamin C, folate, potassium, fiber and many other phytonutrients. They are lower in calories than many foods, therefore, they may help to lower calories intake. Among the potential benefits of eating fruits are those as follows: reduced risk for heart disease, type 2 diabetes, some forms of cancer and other chronic diseases (Kunachowicz et al. 2004).

Metals, including such as Zn, Cu, Mn, Fe are essential for the proper functioning of the human body (Nabrzyski, 2007). They are essential constituents of enzymes, but also regulate variety of physiologic processes (eg. oxygen transport) and are required for growth. On the other hand, they can also pose a threat to our health as their excess results in pathological states (Hayes, 1997; Rojas et al., 1999; Nabrzyski, 2007). Therefore, it is crucial to monitor these metals levels in food products with respect to environmental pollution or contamination during technological processing.

Materials and Methods

The analysed fruits' samples were obtained from the local market in Gdańsk (Poland). In total, 24 products (72 subsamples) were analysed. Prior to analysis, the samples were homogenized and about 10.0 (±0.0001) g products portions were weighed and transferred to quartz crucibles. Samples were ashed in an electric furnace at 540 C with gradual increase in temperature. Next, 1.5 ml of 36,5 % HCl (Tracepur® Merck) and a drop of 65% HNO_3 (Suprapur® Merck) were added to crucible with digested sample. Subsequently, the crucible was placed on a water bath until the evaporation of acids. Then, 1.5 ml of 36,5% HCl (Tracepur® Merck) was added to the residue and crucible covered with a watch glass was heated 1 min on the water bath. After digestion every sample was replenished to 25 ml with deionized water.

Three replicate subsamples of each sample were processed. The levels of four heavy metals (Zn, Cu, Mn, Fe) were determined by flame atomic absorption spectroscopy (FAAS) in Philips PU9100X spectrometer.

The accuracy and precision of the analytical measurements were checked by analysis of the certified reference materials Tea (NCS DC 73351) and Cabbage (IAEA-359). The obtained results were in good agreement with the certified values, i.e. the recoveries and the relative standard deviations (RSD) were >88.1 and <8.0%, respectively.

Correlation analysis of the data obtained was performed using STATISTICA 7.1. for Windows (Copyright© StatSoft, Inc. 1984-2005).

Results and Discussion

The analysed products were characterised by a variable content of Zn, Cu, Fe and Mn. The average concentration of the analysed elements were as follows: 0.16; 0.07; 0.61 and 0.36 mg/100 g, respectively. The greatest Fe, Zn, Cu and Mn concentrations were found in grapefruits (1.56 mg/100 g), raspberries (0.52 mg/100 g), green grapes (0.34 mg/100 g) and blueberries (3.03 mg/100 g), respectively. High levels of Zn were also determined in blackcurrant (0.43 mg/100 g) and litchi (0.42 mg/100 g), whereas of Fe in blackcurrants (1.46 mg/100 g) and raspberries (1.35 mg/100 g). Fruits with the lowest metals' concentration are cherries (0.01 mg Mn/100 g), melons (0.002 mg Cu/100 g), avocado (0.10 mg Fe/100 g) and apples (0.02 mg Zn/100 g).

Similar results to obtained in this work were reported by Souci et al. (2002) and Kunachowicz et al. (2005).

Based on essential elements' concentration in the studied food products, the percentage of realization of the recommended daily intake of each metal was estimated for an adult person. The daily mineral intake (in %) through consumption of 100 g of the analysed products was calculated as DMI = C×100/RDA; where C - element concentration (in mg) in 100 g of a particular product; RDA (Recommended Daily Intake) - according to the National Polish Food and Nutrition Institute (Panczenko-Kresowska, Ziemlański, 2001) or American data (Dietary Reference Intakes 2004).

Based on RDA, consumption of 100 g of the analysed fruits supplies to human body, on average, with 1.11 - 1.55% for Zn, 2.70 - 3.38% for Cu, 12.1 - 18.1% for Mn and 3.38 - 4.06% for Fe.

Correlations analysis has shown significant positive relationships ($p<0.001$) between concentrations of Mn-Zn and Mn-Cu.

Conclusions

The great variations in the results obtained were noticed. In general, fruits with high heavy metals concentration were grapefruits, raspberries, blackcurrants and blueberries. The lowest levels of the analysed elements were found in apples, melons, cherries and avocados.

Based on RDA estimated for trace elements, it was concluded that fresh fruits samples supply organism with small amounts of metals but simultaneously it must be remembered that this type of product is usually used only as a dessert or ingredient in food preparation.

It was found that there is no health hazard associated with exposure to heavy metals via fresh fruits consumption.

Significant correlation coefficients ($p<0.01$ and $p<0.05$) were found between concentrations of some metals in fruits.

References

Dietary Reference Intakes. National Academy of Sciences, 2004. http://fnic.nal.usda.gov/nal_display/index.php?info_center=4&tax_level=3&tax_subject=256&topic_id=1342&level3_id=5140 .

Hayes RB. The carcinogenicity of metals in humans. Canc Caus Contr 1997; 8: 371-385.

Kunachowicz H., Nadolna I., Przygoda B., Iwanow K. (2005). Tabele składu i wartości odżywczej żywności. Wydawnictwo Lekarskie PZWL, Warszawa 2005

Kunachowicz H., Nadolna I., Wojtasik A., Przygoda B. (2004). Żywność wzbogacana a zdrowie. Instytut Żywności i Żywienia, Warszawa.

Nabrzyski M. Functional role of some minerals in foods. In: Szefer P, Nriagu JO, editors. Mineral Components in Foods, CRC Press, Taylor Francis Group, London New York, 2007; pp. 363-388.

Panczenko-Kresowska B, Ziemlański Ś. Składniki mineralne - ich znaczenie w żywieniu człowieka. In: Ziemlański Ś, editor. Normy żywienia człowieka - fizjologiczne podstawy. Wydawnictwo Lekarskie PZWL, Warszawa, 2001.

Rojas E, Herrera LA, Poirier LA, Ostrosky-Wegman P. Are metals dietary carcinogens? Mutation Res 1999; 443: 157-181.

Souci S.W., Fachmann W., Kraut H. Food composition and nutrition tables. Scientific Publishers, Stuttgart 2002.