Determination of Tin in Canned Foods by Atomic Absorption Spectrometry

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Abstract: Atomic absorption spectrometry is a powerful technique for determination of tin in canned foods. Homogenous samples of syrup and solid parts were digested by means of microwave digestion system MLS 1200 MEGA where hydrochloric and nitric acid were used as reagents. The measurements were carried out using a Perkin-Elmer AAnalyst 700 atomic absorption spectrometer. Detection limit was 4 mg/kg in nitrous oxide and acetylene flame. There were analysed 222 samples of 26 various kinds of canned fruit (e.g. pineapple, peach, mandarin), vegetables (e.g. bean, mushroom, tomato) and meat (sea products) in this work. The analytical results indicated tin total concentrations from under 4 mg/kg to 353 mg/kg. Different concentrations of tin between syrup and fruit were observed. The concentration of tin was higher in solid parts than in syrup. Relationship between the concentration and time period after opening was studied. The corrosion of the tinplate surface was accelerated by air and the amount of dissolved tin was significantly increasing in syrup as well as fruit when cans were opened and stored for two days at 6°C.

Keywords: tin; canned food; atomic absorption spectrometry

INTRODUCTION

The acute toxicity of inorganic tin is manifested as gastric irritation, nausea, vomiting and abdominal discomfort. Inorganic tin salts are poorly absorbed by the gastrointestinal tract and rapidly excreted. Nevertheless, there are several case reports of gastric irritation and vomiting in humans consuming canned foods or beverages, particularly sour fruit products packaged in tinplate cans and containing high levels of tin. Food and especially canned food represent the main source of human exposure to tin. Maximum level of tin in canned foods is 200 mg/kg for canned foods other than beverages and 100 mg/kg for canned beverages, including fruit and vegetable juices (Commission Regulation EC No 1881/2006).

Techniques that are most commonly used for determining tin are UV/VIS spectrophotometry (Huang *et al.* 1997), X-Ray fluorescence spectrometry (Mino 2006), inductively coupled plasma atomic emission spectrometry (Perring & Basic-Dvorzak 2002) and electrothermal atomic absorption spectrometry (Chiba 1987). In this work, we describe determination of tin by flame atomic absorption spectrometry in various kinds of canned foods.

MATERIALS AND METHOD

Materials. A total of 222 samples of can (from years 2004–2008) made from 26 different kinds of fruit, vegetables and meat were analysed. All reagents were of analytical purity grade or higher.

Method. Tin in total amount was determined by flame atomic absorption spectrometry (F-AAS). The samples of syrup were digested in MLS 1200 MEGA (Milestone, Italy) microwave digestion system. The 1 g homogenate of syrup or fruit was added to 4 ml nitric acid (Merck, Germany) and 4 ml hydrochloric acid (Lachema, Czech Republic). The digested samples were transfered to tube with 1.2 ml of potassium chloride as an ionisation buffer and adjusted to the volume of 15 ml with ultrapure water.

The measurements were carried out using a Perkin-Elmer AAnalyst 700 type atomic absorption spectrometer. The 286.3 nm resonance line was generated by a Perkin-Elmer electrodeless discharge lamp with 300 mA input current and the transmitted spectral interval 0.7 nm. The samples were nebulised by a high sensitivity nebuliser to nitrous oxide and acetylene flame (rate of flow 11.9/5.0 l/min). The accuracy of measurement was checked by using Certified Reference Material T07103 Tomato paste – assigned value 306 ± 42 mg/kg, measured value 302 ± 60 mg/kg.

Table 1. Concentrations of tin, determined by F-AAS (mg/kg)

	n	Minimum	Maximum
Aloe vera	1		< 4.0
Apricot	10	5.30	154
Artichoke	1		89.2
Asparagus	2	< 4.0	26.6
Bamboo	2		< 4.0
Bean	14	< 4.0	**353**
Can meat	5	< 4.0	8.85
Coconut milk	2		< 8.0
Fruit cocktail	9	6.30	166
Grapefruit	5	44.3	**311**
Kiwi	1		< 4.0
Lychee	3	68.8	138
Maize	4	< 4.0	5.43
Mandarin	27	34.5	142
Mango	6	< 4.0	39.9
Mushrooms	14	< 4.0	189
Papaya	4	< 4.0	7.88
Peach	17	30.5	209
Pear	8	< 4.0	97.8
Peas	12	< 4.0	10.1
Pineapple	42	24.1	238
Rambutan	2	56.9	73.4
Raspberry	3	< 4.0	5.55
Soya shoot	2		< 4.0
Strawberry	20	< 4.0	6.00
Tomato	6	5.80	109

n = number of samples

RESULTS AND DISCUSSION

Table 1 shows the results of total amount of tin from monitored cans by atomic absorption spectrometry. The analytical results indicated tin total concentrations from under 4 mg/kg to 353 mg/kg. Maximum permissible level of tin 200 mg/kg was exceeded in cases of beans (353 mg/kg) and grapefruit (311 mg/kg). An enhanced amount of tin was observed for example by canned apricots, mushrooms, mandarins, peaches, pineapple, fruit cocktail and tomatos. However, maximum level was not exceeded with regard to expanded uncertainty of measurement. The very low amount (less than 4 mg/kg) of tin was observed for example in strawberries, raspberries, and canned meat. The higher content of tin was observed in cans with sour products and products in uncoated cans.

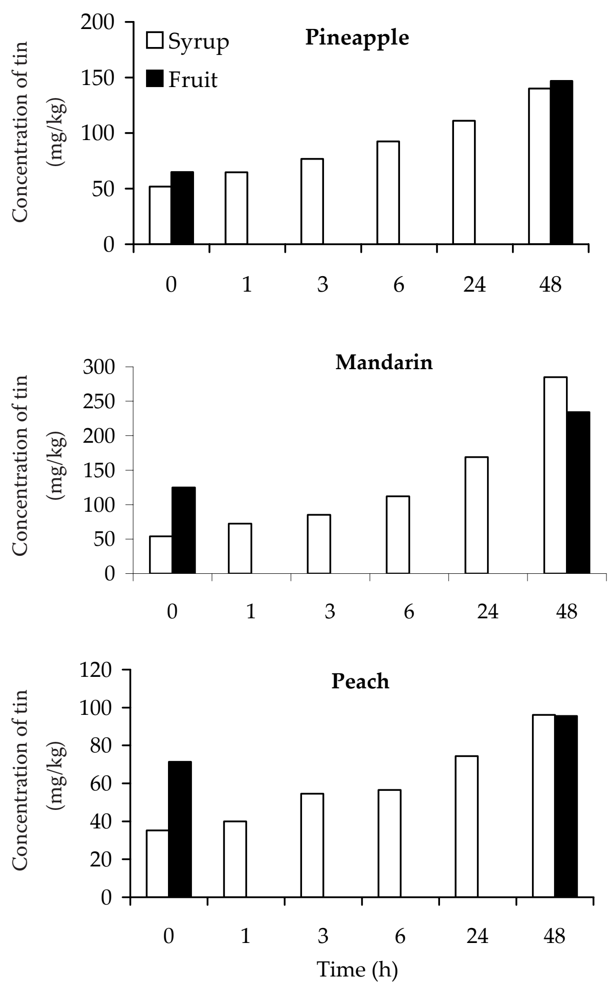

Figure 1. Dependence of standing in an opened can (at 6°C) on tin content in syrup and fruit

Different concentrations of tin between syrup and fruit were observed. Samples of canned mandarins and pineapple were used for this experiment. The content of can was separated into syrup and solid parts. Some amount of tin was determined in both. 52–64 mg/kg of tin for syrup samples and 65–133 mg/kg of tin were observed for solid part. The concentration of tin was higher in solid part than syrup. As syrup of pineapple contained very small parts was filtered and amount of tin was determined in pure syrup and small part from the filter. The amount of tin in syrup was 48 mg/kg, but in the filtered parts 728 mg/kg. However, these small parts composed less than 1% of total content of can. These results might be accounted for by the adsorption capacity of tin on the surface.

Relationship between the concentration and time period after opening was studied. For this experiment were used samples of canned mandarins, pineapple and peaches. The content of can was separated into two parts. In the first part was immediately determined concentration of tin in syrup and fruit. The second part of can was stored at 6°C. The concentration of tin in syrup after 1, 3, 6 and 24 h was determined by duration of experiment. Amount of tin in both parts was determined after 48 hours. All results are summarised in Figure 1. The corrosion of the tinplate surface was accelerated by air and the amount of dissolved tin was significantly increasing in syrup as well as fruit when cans were opened and stored for two days at 6°C.

CONCLUSION

The results of this work showed that more than 98% of investigated canned food samples contained less than 200 mg/kg. The highest concentrations of tin were found in canned sour fruits and vegetables and products in uncoated cans.

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