Evaluation of the Content of Lead, Cadmium, Mercury, Arsenic, Tin, Copper and Zinc during the Production Process Flow of Tomato Broth

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Abstract. Heavy metals are among the largest contaminants of food products. Once metals are present in vegetables, their concentrations are rarely modified by industrial processing techniques, although in some cases washing may decrease the metal content. The main objective of this study was to quantify the effect of industrial processing on the content of lead, cadmium, mercury, arsenic, tin, copper and zinc in tomatoes and products resulting on flow technology of tomato broth. For the determination of essential elements and/or potentially toxic was use atomic absorption spectrometry. The analytical results for quantitative evaluation the concentrations of the investigated elements on the samples of tomatoes taken from the technological process of the production of tomato broth indicated the presence of Pb, Cd, Cu and Zn but with a level of concentration that significantly decreased in the finished product and the absence of metals Hg and As in all investigated samples. Effect of industrial processing on the content of tin in tomato samples analyzed was characterized by fluctuations in the residual content that led to a significant increase in concentration of $0.100 \pm 0.041 \text{ mg kg}^{-1}$ (tomatoes - unprocessed) to $0.200 \pm 0.041 \text{ mg kg}^{-1}$ (tomato broth).

Keywords: essential elements and/or potentially toxic, industrial processing, tomato, tomato broth

Introduction. Heavy metals are among the major contaminants of food supply and may considered the most important problem to our environment. In general, heavy metals, are not biodegradable, have long biological half-lives and have the potential for accumulation in the different body organs (Radwan and Salama, 2006).

The content of heavy metals varies significantly depending on the plant species. Tomatoes can tolerate large amounts of heavy metals without toxic effects.

Typical stages used in processing fruits and vegetables, such as washing, peeling, blanching and sterilization may change the composition of essential elements as well as of the toxic elements. Also, washing vegetables allows the diffusion of ions in the apoplast. Enrichment of food with heavy metals, may be contacted processing machines, storage in metal cans, containers alloys using heavy metals (lead, iron, chromium, aluminum, copper, zinc, tin, arsenic) corresponding uninsulated (Beceanu, 2010).

Toxic elements (Pb, Cd, Hg) are chemical elements very stable, not heat or chemically degrade, but depending on how they can link to migrate.

Aims and objectives. The main objective of this study was to quantify the effect of industrial processing, including washing steps, mechanical shredding, preheating, remove residue of skin/seed, concentration and pasteurization on the content of Pb, Cd, Hg, As, Sn, Cu and Zn in tomatoes and products resulting on flow technology of tomato broth.

Materials and methods. Tomatoes were collected from a processing unit of vegetables and fruits in Galati County and analyzed in five stages. For the determination of essential elements and/or potentially toxic was use atomic absorption spectrometry. Cadmium, Cr and Pb was analyzed on Graphite Furnace Atomic Absorption Spectrophotometer, As and Hg on Atomic Absorption with Hydride Generation and Cu, Zn and Sn by Flame Atomic Absorption Spectrophotometry.

Results and Discussion. The mean concentrations and standard deviation of heavy metals found in tomatoes sampled (Pb, Cd, Sn, Cu and Zn) are summarized in Tab. 1. The heavy metal concentrations determined were based on sample dry weight.

Tab. 1

Concentration of toxic and essential elements (mean $\pm$ SD, in mg kg⁻¹ dry wt)
from tomatoes during processing

Specification	Pb	Cd	Sn	Cu	Zn
Tomatoes - unprocessed	0,2275 $\pm$ 0,025	0,0155 $\pm$ 0,005	0,100 $\pm$ 0,082	12,565 $\pm$ 2,665	4,142 $\pm$ 0,439
Tomatoes - whasing	0,2400 $\pm$ 0,022	0,0150 $\pm$ 0,003	0,150 $\pm$ 0,058	12,525 $\pm$ 1,533	3,727 $\pm$ 0,519
Mechanical shredding	0,1500 $\pm$ 0,026	0,0135 $\pm$ 0,001	0,125 $\pm$ 0,050	11,610 $\pm$ 0,470	3,517 $\pm$ 1,003
Preheating	0,2200 $\pm$ 0,045	0,0125 $\pm$ 0,001	0,175 $\pm$ 0,096	11,187 $\pm$ 0,025	3,532 $\pm$ 0,234
Concentration and pasteurization (finished product)	0,1350 $\pm$ 0,031	0,0028 $\pm$ 0,001	0,200 $\pm$ 0,082	3,385 $\pm$ 0,492	2,565 $\pm$ 0,091
Residue (skin/seeds)	0,2450 $\pm$ 0,044	0,0145 $\pm$ 0,001	0,225 $\pm$ 0,096	11,055 $\pm$ 0,846	3,362 $\pm$ 0,536

Influence of technological process on lead content in tomatoes led to fluctuations in the content during subsequent processing. The results showed that the levels of Pb in all samples of tomatoes were between 0.2400 mg kg⁻¹ in tomatoes after whasing and 0.1350 mg kg⁻¹ in tomato broth. The stages of processing tomatoes: washing, mechanical shredding preheating, concentration and pasteurization, decreased successive the average concentration of cadmium residual up to 81.93%, from 0.0155 mg kg⁻¹ to 0.0028 mg kg⁻¹.

Another chemical element from group of metals in samples of tomatoes investigated in the study is copper. Analyzed as a whole the results it is noted that the average concentration of Cu registered decreases significant by the concentration step followed by pasteurization of 69.74%, from 11.187 mg kg⁻¹ to 3.385 mg kg⁻¹.

Like Cu, Zn is an essential element for plants. Sufficient Zn is essential to neutralize the toxic effects of Cd. In this study, maximum quantity of zinc was detected in tomatoes unprocessed (4.142 mg kg⁻¹) while tomato broth had the lowest concentration (2.565 mg kg⁻¹).

Tin content of tomatoes samples showed a significant increase by applying heat treatments. Quantitative tomato broth expressed a higher average concentration in tin (0.100 mg kg⁻¹) compared to unprocessed tomatoes (0,225 mg kg⁻¹).

Residual concentrations of Pb, Cd, Cu, Zn and St of skin and seed residue from the processing of tomatoes recorded high values.

Tomatoes samples analyzed for Hg and As content have yielded values below the detection limit.

Conclusion

Tomato samples analyzed for average content Pb, Cd, Cu and Zn have resulted in values that were significantly reduced (except for residual tin) after processing into tomato broth.

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