Presence of heavy metals in fruits from *Prunus* genera

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Abstract The environment pollution with heavy metals is due mainly to the activity of humans. High quantities of these metals can be toxic for all organisms. The entry of heavy metals from the polluted environment in fruits and plants is influenced by different factors and stopped through several mechanisms. Their presence can have effects on different physiological processes: photosynthesis, respiration, transpiration, cell membrane permeability. Using heavy metal contaminated vegetal products in alimentation can have important effects on short or long terms, depending on the intensity and action period of the polluting factor. The objective of present work was to investigate the presence of heavy metals (Cd, Cu and Pb) in different stages of cherry, sour cherry and apricot growing. Atomic absorption spectrometry in air/acetylene flame was used to estimate and evaluate the levels of these metals in fruits from *Prunus* genera. The highest cadmium's concentration was found in almost ripe sour cherry (0.647 mg/Kg) while plumb was not detected in studied fruits. The accumulation of investigated metals is different depending on the stage of development.

Keywords: Cd, Cu, Pb, cherry, sour cherry, apricot, flame atomic absorption spectrometry

1. Introduction

Incidences of food contamination have become increasingly frequent in recent years raising question about their human health and economic consequences [1].

Prunus avium (cherry), *Prunus cersus* (sour cherry) and *Prunus armeniaca* (apricot) belong to the same family: *Rosaceae*, *Prunoidae* subfamily and *Prunus* genera. *Prunoidae*, also called *Amygdaloideae* is the flowering plant subfamily. The fruit of these plants are known as stone fruit (botanically, a drupe), as each fruit contains a single, hard-shelled seed called a stone or pit [2].

It is generally considered that heavy metals originate from two primary sources: natural inputs (e.g. parent material weathering) and anthropogenic inputs (e.g. metalliferous industries and mining, vehicle exhaust, agronomic practices, etc.) [3].

Lead and cadmium are toxic elements. Both metals cause adverse health effects in humans and their widespread presence in the human environment comes from anthropogenic activities. The most important sources of lead exposure are industrial emissions, soils, car exhaust gases and contaminated foods. The entrance of lead at levels >0.5–0.8 lg/mL into blood causes various abnormalities. Lead accumulates in the skeleton, especially in bone marrow. It is a neurotoxin and causes behavioural abnormalities, retarding intelligence and mental development. It interferes in the metabolism of calcium and vitamin D and affects haemoglobin formation and causes anaemia. Cadmium ions are easily absorbed by vegetables and, in animal-based food, are principally distributed in the liver and kidneys [4].

A number of studies have shown heavy metals as important contaminants of the fruits and vegetables [5-9].

The objective of present work was to investigate the presence of heavy metals (Cd, Cu and Pb) in different stages of cherry, sour cherry and apricot growing from urban (Cernavoda) and rural areas (Mereni).

2. Experimental

2.1. Reagents and solutions

All metal stock solutions (1000 mg/L) were prepared by dissolving the appropriate amounts of the spectral pure metals in dilute acids (HNO_3) 1:1 and then diluting them with deionised water. The working solutions were prepared by diluting the

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stock solutions to appropriate volumes. The nitric acid 65% and hydrogen peroxide 25% solutions used were of ultra pure grade, purchased from Merck. All reagents were of analytical-reagent grade and all solutions were prepared using deionised water.

2.2. Sample preparation

Cherry, sour cherry and apricot in different stages of growing from urban (Cernavoda) and rural (Mereni) areas were investigated. In order to determine metals concentrations, the samples were washed with deionised water, dried and homogenized. 0.5-0.9 grams of each dry sample was submitted digestion with 8 mL HNO_3 65% and 10 mL H_2O_2 25% at 150°C in a Digesdhal device provided by Hach Company [10]. After the complete digestion the samples solution was filtered, made up to 50 mL in volumetric flask with deionised water.

2.3.Sample analysis

In order to measure the metals concentration in analyzed samples a calibration curve was obtained.

Analyses were made in triplicate and the mean values are reported.

A Shimadzu atomic absorption spectrometer (Model AA 6200) equipped with air-acetylene flame was used for the determination of metals (Cd, Cu and Pb) in fruits. Acetylene of 99.99% purity at a flow rate of 1.8-2.0 L/min was utilized as a fuel gas and also as a carrier gas for introducing aerosols. Concentrations of metals were measured using monoelement hollow cathode lamps.

2.4. Quality assurance procedure

The recovery of the method was tested continuously by fortified clean samples with each of the metals at concentration levels ranged between 0.1 and 0.3 mg/kg and processed as previously described. The average recoveries ranged between 97 and 102%. Sample blanks were analyzed with every set of samples and the detection and quantification limits were estimated for each measured metal using the formulas: $(3 \cdot S_a - a)/b$ and $(10 \cdot S_a - a)/b$, respectively, where b is the slope of the calibration curve and S_a is the standard deviation of intercept of regression equation.

For the analyzed metals, the detection limits ranged between 0.01 and 0.015 mg/kg and quantification limits between 0.07 and 0.1 mg/Kg.

3. Results and Discussions

In tables **1, 2** and **3** are presented the average values of Cd, Cu and Pb concentrations in fruits grown in urban garden, Cernavoda (cherry and sour cherry) respectively in rural garden, Mereni (apricot).

It can be noticed that the concentration of metals in fruits varies with the stage development and studied metals exhibit a different distribution pattern.

The highest cadmium's concentration was found in almost ripe sour cherry (0.647 mg/Kg) while plumb was not detected in studied fruits.

Table 1. Metal concentrations (mg/Kg dry weight) from cherry grown in urban area (Cernavoda)

Metals	Cherry		
	Green	Almost ripe	Ripe
Cd	0.245	0.431	0.123
Cu	3.09	4.13	3.87
Pb	ND	ND	ND

Table 2. Metal concentrations (mg/Kg dry weight) from sour cherry grown in urban area (Cernavoda)

Metals	Sour Cherry		
	Green	Almost ripe	Ripe
Cd	0.307	0.647	0.221
Cu	4.85	2.38	ND
Pb	ND	ND	ND

Table 3. Metal concentrations (mg/Kg dry weight) from apricot grown in rural area (Mereni)

Metals	Apricot		
	Green	Almost ripe	Ripe
Cd	<LOQ	<LOQ	<LOQ
Cu	ND	1.06	2.38
Pb	ND	ND	ND

The recommendable maximum limits for metals in fruits are 0.05 mg/Kg for Cd, 0.5 mg/Kg for Pb and 5 mg/Kg for Cu [10].

It can be noticed that all values of cadmium concentrations from urban areas are over the recommendable maximum limit of this metal in fruits. In general, the major pathways through which cadmium is released to the environment are to the atmosphere during fuel combustion, smelting, incineration of trash; to water via sewage and wastewater discharging (water contamination during battery, paint, plastics production, during soldering) point and nonpoint source runoff associated with the application of phosphate fertilizers and biosolids (product of sewage sludge); and as leachate from soils, landfills, and groundwater. The release via incineration and smelting processes produces fine airborne particles that attach quickly to dry or wet particles that can then be transported relatively long distances (miles) away from the source [11].

In Cernavoda area the major pathway through cadmium is released is fuel combustion because the highway is very near the Cernavoda town.

Lead and cooper's concentrations are lower than their maximum limit values.

Moseholm et al. [12] observed a linear relationship between air-borne Pb and its foliar concentrations in kale and Italian rye grass and showed that the magnitude of uptake was dependent upon atmospheric concentrations. Regarding Cu, soil appeared almost equally responsible for raised levels in leaves. This might be due to mobilization of Cu to leaves after uptake from soil.

Saracoglu et al. [13] have found in dried apricots the following concentrations: Cu 0.92-6.49 ppm; Cd 0.02-0.72 ppm and Pb 0.72-3.77 ppm. These results are in concordance for cooper and cadmium and higher for lead.

Heavy metal concentration varied with species and with stage of growing of fruit considered for analysis. This is due probably to variable capabilities of plants to absorb and accumulate heavy metals. Furthermore, variations in growth period and growth rates as well as in physical and chemical properties of soil also affect heavy metal uptake [14].

4. Conclusions

This paper presents original data concerning distribution of Cd, Cu and Pb in different stages of cherry, sour cherry and apricot growing.

The highest cadmium's concentration was found in almost ripe sour cherry (0.647 mg/Kg) while plumb was not detected in studied fruits.

In Cernavoda all values of cadmium concentrations are over the recommendable maximum limit, because the highway is very near the town and fuel combustion can be the major pathway through cadmium is released in atmosphere.

The accumulation of investigated metals is different, depending on the stage of development.

5. References

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