International Journal of Research in BioSciences
Volume 10 Issue 3, pp. (1-7), July 2021
Available online at http://www.ijrbs.in
ISSN 2319-2844

Research Paper

Measurement of trace elements (Pb, Cd) in fruits and vegetables: Case of sidi bel abbes -western Algeria

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(Received March 17, 2021, Accepted June 30, 2021)

Abstract

Pollution with metal and trace elements (MTE) has become a public health concern, the contamination of soil, air, water and living beings by heavy metals is partly due to multiple human activities. This study consists of a quantitative evaluation of heavy metals (Pb, Cd) in six random samples and without a standard deviation of fruits and vegetables (potato, tomato, zucchini, lettuce, apple, strawberry) from merchants and markets of the city of Sidi Bel Abbes. Algérie. In order to be able to determine the content of Pb and Cd in the plants mentioned above, atomic absorption was carried out which allowed us to appreciate the variations of the various trace elements from one plant to another. The results obtained show that the lead and cadmium contents in the samples vary respectively between a maximum value of 0.981mg / kg and .0182mg / kg and a minimum value of 0.003mg / kg and 0.009mg / kg. There is a difference in the lead contents for the six samples analyzed: Pb (potato)> Pb (strawberry)> Pb (zucchini)> Pb (tomato)> Pb standards. Lettuce and apple are within the regulated content. The presence of cadmium also varies from sample to sample: Cd (tomato)> Cd (zucchini)> Cd (potato)> Cd (strawberry). These variations are due to are due to a "compartmentalisation of heavy metals in the plant agriculture (spreading sludge from wastewater treatment plants, fertilizers and certain phytosanitary treatments for crops) and road transport.

Keywords: metal trace elements, quantitative evaluation, plomb, cadmium, fruits, vegetables, Sidi Bel Abbes.

Introduction

Heavy metals come in different forms, and are ubiquitous in the environment, they are found in agricultural soils naturally as they are components of the earth's crust, but they are also found in cultivated plants and can cause safety problems in agricultural products intended for human consumption[1]. The metallic or metalloid elements are called "traces" because their concentration in the earth's crust and living organisms is generally low, hence their name "metallic trace elements" (MTE), or heavy metals, they designate trace elements essential to the various biological processes but can be dangerous up to toxic at high levels[2.] Heavy metals have been reported to have a positive and negative role in human life[3-5]. Cadmium, lead and mercury are known to be toxic to humans and are their third source of risk after mycotoxins and microorganisms. In study [6] and wildlife, they are major contaminants of the food supply and can be considered the most important problem for our environment, in general most of the heavy metals are not biodegradable they have a very long biological life and can accumulate in the different organs of the body[7,8], while others such as iron, zinc and copper are essential for biochemical reactions in the body[9]. The consumption of fruits and vegetables is essential for, 1-provide nutrients to the human body they are sources of cellulose, hemi-cellulose and pectin that give them their texture and firmness[10], minerals and phytochemicals the

latter function as antioxidants, phytoestrogenes and anti-inflammatory agents[11], 2-reduces the tendency of cardiovascular diseases[12].

Fruits and vegetables are very important in a healthy diet and are generally safe for food consumption, but the accumulation of their contaminants in the body of consumers over a long period of time is a major concern as it can lead to serious health problems, their quality is as important as their quantity. Therefore, fruits and vegetables are a very important class of foods and are very useful for the maintenance of health and as a preventive treatment for various diseases[13].

European regulations set limit values in particular for lead and cadmium in foodstuffs (EC Regulation 1881/2006) which made it possible to monitor the compliance of several foods with the maximum limit set by EC. Food quality assurance with respect to the concentration of heavy metals is therefore important for good health and cannot be underestimated. The determination of these heavy metals is a common practice throughout the world; many studies have been carried out in this axis. The consumption of heavy metals by humans through fruit and vegetables is a major concern as it has a direct impact on health. The determination of the concentration of heavy metals in: potatoes, tomatoes, zucchini, lettuce and apples would help to know whether the latter meet EC standards or not.

This study is particularly important for Algerian agricultural products where only limited and very weak data are available because there are not enough studies found on the concentrations of heavy metals in fruits and vegetables in Algeria., although regular monitoring and assessment of the concentration of heavy metals in vegetables and fruit have been reported in developed countries and some development of these agricultural products (potato, tomato, zucchini, lettuce and apple) very consumed by the Algerian population. The aim of the study was therefore to establish quantitatively a possible contamination by heavy metals of these market fruits and vegetables and merchant, in the town of sidi bel abbés, west Of Algeria, in order to: compare the results with those available in the literature and the tolerable limits of the EC recommendations.

Materials and Methods

Sampling (Origin and number of samples)

Our choice is based on various plant products which are the most consumed food in the region in wstern algeria. For this purpose six samples bought on the local market, and at fruit and vegetable vendors in the city of Sidi Bel abbes - ALGERIA - at random:-Potato (*Solanum tuberosum),* Tomato *(Solanum lycopersicum),* Zucchini *(Cucurbita pepo),* Laitue *(actuca sativa),* Apple*(plantae),* - Strawberry *(Fragaria vesca)*: Our samples were taken between 04/22/2019 and 04/24/2019, a sample of 250g was purchased for each type, for a total of six samples of 250g each. The latter were properly washed after the bruised and rotten parts were removed, labeled, stored in plastic bags, then refrigerated for a maximum of 24 hours cold before being analyzed.

Table 1: description of the samples fruits and vegetables (Potato, Tomato, Courgette, Lettuce, Apple)

The nature of the sample	Origin	Place of sample
Potato	Vegetable	Market
Tomato	Fruit-vegetable	Market
Courgette	Fruit-vegetable	Walking fruits and vegetables
Lettuce	Vegetable	Walking fruits and vegetables
Apple	Fruit	Walking

Preparation and processing of samples

The samples taken were processed no later than 24 hours after collection. The fruits were rinsed in bi-distilled water, peeled, sliced to obtain the edible part for analysis. The vegetables were also rinsed in bi-distilled water and chopped.

The weighing

A random standard deviation free sample of 5g of each sample, with three repetitions on each food, were weighed with precision using a precision balance and placed in a teflon bomb with 5 ml of nitric acid then hermetically closed. Leave overnight (predigestion) which will promote the spread of ETM.

Mineralization
put the Teflon bombs in a 120°sand bath for 4 hours, after this time allow the Teflon bombs to return to room temperature before decapsulation.

Atomic absorption spectrophotometry
We used a Thermo-Fischer type M6 Atomic Absorption spectrophotometer with graphite furnace.
Atomic absorption spectrophotometriy is a process takes place when an atom belonging to the ground state goes in to the excited state by absorbing energy in the form of electromagnetic radiation which corresponds to a length of specific wave.

The atomic absorption spectrum of an element is made up of a series of resonant lines that all originate in the ground electronic state and end in different excited states. Transitions between the ground state and the excited state occur when the incident radiation is exactly equal to the frequency of a specific transition. Part of the energy of the incident radiation I0 is absorbed, the emitted radiation is given by I.

$$I = I_0 e^{-(\varepsilon l)}$$

Ɛ: absorption coefficient of the element to be analyzed
I^0: the length of the horizontal path of the radiation through the chamber absorption[14].

Results and discussion

Atomic absorption spectrophotometry (We used a Thermo-Fischer type M6 Atomic Absorption spectrophotometer with graphite furnace) is best suited for this study because it is fast, due to the small amount of solvents and few matrices used. The qualitative and quantitative results of heavy metals in the selected fruits and vegetables obtained in this study are presented in Table 1 to 2.

Table 1: Means of heavy metal concentration (mg/kg) and qualitative results of heavy in some fruits and vegetables from Sidi Bel Abbes-Algerie

Samples	Pb	Cd	Pb (Detected)	Cd (not detected)
Potato	0.981	0.087	+	+
Tomato	0.110	0.182	+	+
Courgette	0.151	0.089	+	+
Lattuce	0.293	0.072	+	+
Apple	0.003	0.009	+t	+
Strawberry	0.158	0.075	+	+

The results obtained are summarized in Table 1. The results obtained show that the lead and cadmium contents in the samples vary respectively between a maximum value of 0.981mg / kg and .0182mg / kg and a minimum value of 0.003mg / kg and 0.009mg / kg. These variations are due to a "compartmentalisation of heavy metals in the plant[15].

Table 2: Summary table of the Pb and Cd contents in the six samples (mg/kg)

Average heavy metal content (mg / kg)	Pb		Cd	
	Results	Maximum concentration regulated according to EC (mg / kg)	Results	Maximum concentration regulated according to EC (mg / kg)
Potato	0.981	0.1	0.087	0.1
Tomato	0.110	0.1	0.182	0.05
Zucchini	0.151	0.1	0.089	0.05
Lettuce	0.293	0.3	0.072	0.2
Apple	0.003	0.1	0.009	0.05
Strawberry	0.158	0.1	0.075	0.05

The heavy metal contents detected in the six samples showed in the potato sample shows a very high concentration of Pb (0.981mg / kg), a value far exceeding the standard (9 times the maximum regulated concentration). The Cd content remains close to the authorized limit (0.087mg / kg) by CE

1880/2006 standards (0.1mg / kg). In The tomato, contents of 0.110mg / kg for Pb and 0.182 mg/kg for Cd, the concentration of the latter exceeds the regulated maximum level which is 0.1mg / kg for Pb and 0.05mg / kg for Cd. The courgette, The Pb and cadmium with levels of 0.151mg / kg and 0.089mg / kg, these rates remain high compared to the regulated standards (0.1mg / kg for Pb and 0.05mg / kg for Cd).

The following histograms in Figure 1 highlight the results of the samples and the EC standards.
In order to better appreciate and compare the different results with CE standards, we have established a histogram (figure 1) which will clearly reflect the variations in the contents of each metalloid in the six samples analyzed. The Pb content (0.293mg / kg) in lettuce is almost equal to the maximum regulated quantity (0.3mg / kg). The presence of Cd is significantly lower than the authorized concentration. The apple has the lowest levels of lead and cadmium, it is the most compliant with standards with values well below the maximum regulated concentration. The strawberry, this sample in turn has levels of 0.158mg / kg of lead and 0.075mg / kg of cadmium exceeding the regulated concentrations which are 0.1mg / kg for lead and 0.05mg / kg for cadmium.
There is a difference in the lead contents for the six samples analyzed:
Pb (potato)> Pb (strawberry)> Pb (zucchini)> Pb (tomato)> Pb standards.
Lettuce and apple are within the regulated content.
The presence of cadmium also varies from sample to sample: Cd (tomato)> Cd (zucchini)> Cd (potato)> Cd (strawberry).
Lettuce and apple have Cd content that meets standards.

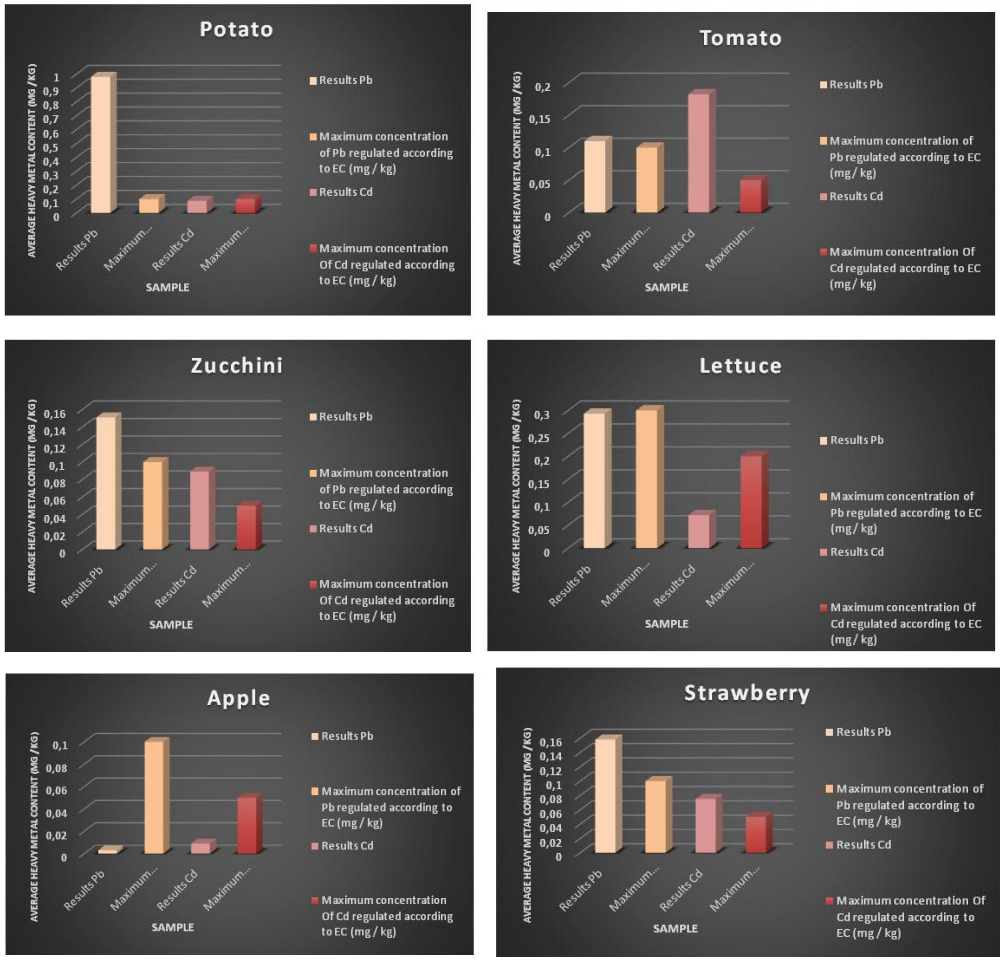

Figure 1 : Histogram illustrating the comparison between the content of Pb, Cd and CE 1881/2006 standards in potato, tomato, lettuce, apple and strawberry

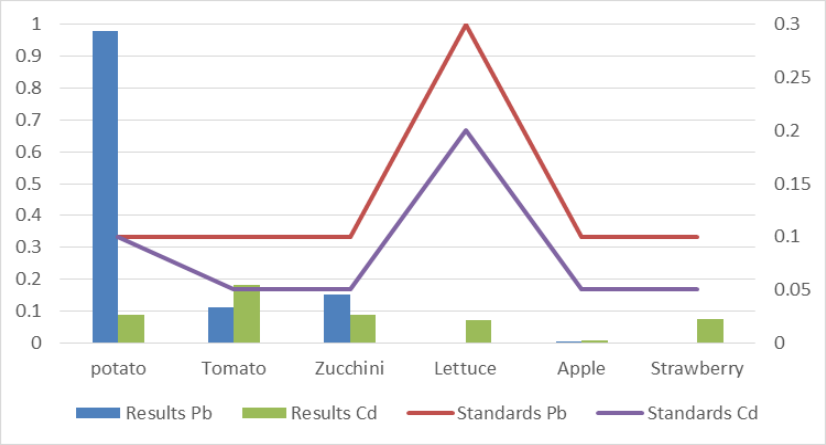

Figure 2: Histogram illustrating the comparison between the content of Pb, Cd and CE 1881/2006 standards

Depending on the Pb and Cd contents in the six plants, a classification is possible in decreasing order of absorption: Potato: Pb> Cd, Tomato: Cd> Pb, Courgette: Pb> Cd, Lettuce: Pb> Cd, Apple: Cd> Pb, Strawberry: Pb> Cd. Quantitatively lead is the dominant cation in the six samples (4/6) with a content exceeding the authorized concentration. Cadmium is the element present in all samples but at low content and very close to the limit value of the standard. All these values oscillate from one sample to another, generally exceeding the value prescribed by the adopted standard. This means that all food except lettuce and apple are not compliant and cannot be intended for human consumption.

Several sources can be at the origin of these heavy metals:

1. Sedimentary rocks that contain high amounts of Pb and Cd, than other rocks. The presence and their distribution of these metals in the soil results from the phenomena of biogeochemical alteration of the bedrock and from pedological processes such as the formation of horizons[16,17].

2. Anthropogenic origin is a major source of ETM leading to irreversible pollution[18]. The deposition of ETMs and their dispersion in the environment via human activity are linked to several factors. These can be interventions from industries, town planning (public landfill, leachate, transport, heating), agriculture (spreading sludge from wastewater treatment plants, fertilizers and certain phytosanitary treatments for crops) and road transport[19,20].

In several countries such as England, Wales[21] and France[22], there is an increase in MTE content in soils following the application of fertilizers, sewage sludge or due to atmospheric deposition. The latter two causes were the main source of most MTE, in particular Zn, Cu and Pb, on all farmland in England and Wales. Also, a study carried out in 12 different European countries showed that the contribution of ETM via phosphate fertilizers was greater than via atmospheric deposition in European agricultural soils for Cd, As and Cr, unlike Zn, Ni and Pb which mainly come from atmospheric deposition[23]. Therefore the source of Pb and Cd in the six samples must surely originate from: the use of sewage sludge, atmospheric deposits, Phosphate fertilizers[21-25].

Conclusion

The consumption of fruits and vegetables is very important; they are the basis of our everyday dishes. Therefore, they must comply with the content of heavy metals in order to avoid any risk to the health of the consumer. It is therefore important to carry out more in-depth studies and target the different sources of TME and their passage through the different trophic levels. We tested for the presence of two heavy metals Pb and Cd in six samples of fruits and vegetables (potato, tomato, zucchini, lettuce, apple and strawberry) using atomic absorption spectrophotometry. The results showed a Pb and Cd rate exceeding the maximum regulated concentration in potato, tomato, zucchini, and strawberry which means that all these foods except lettuce and apple are not compliant and may not be intended for human consumption. Knowing that lead in high levels accumulates and diffuses in the body to reach the brain and other tissue. As for cadmium, its accumulation in the body can cause chronic

pathologies in humans known as lead poisoning, which causes mainly hematological, neurological and renal toxicity.

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