Determination of heavy metals (Pb and Cd) in guava pulps (*psidium guajava*) obtained in the city of Cartagena

Determinación de metales pesados (Pb y Cd) en pulpas de guayaba (psidium guajava) obtenidos en la ciudad de Cartagena

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Resumen

El objetivo de este estudio fue determinar los niveles de acumulación de metales pesados como el cadmio (Cd) y el plomo (Pb) derivados de actividades antropogénicas, como los humos metálicos de la soldadura y el tráfico de vehículos, en la pulpa de guayaba (Psidium guajava) en la ciudad de Cartagena. -Bolívar. Las muestras se dividieron en tres (3) grupos según la proximidad de las fuentes de contaminación. En el grupo 1, menos de 100 m de industrias metalúrgicas, las concentraciones de Cd en el rango de 0.0400 ± 0.33 mg / Kg y 0.0483 ± 0.15 mg / Kg, mientras que los valores de Pb oscilaron entre 0.036 ± 0.22 mg / kg y 0.060 ± 0.01 mg / kg . Para el grupo 2, se tomaron muestras en 3 lugares donde no se identificó claramente ninguna fuente de contaminación, lo que resultó en concentraciones de Cd 0.0215 ± 0.05 mg / Kg y 0.0260 ± 0.10 mg / Kg, mientras que para el Pb solo se encontró en una de las muestras cuyo valor fue 0.035 ± 0.15 mg / Kg. Finalmente, para el grupo 3, se tomaron muestras en 2 ubicaciones ubicadas a menos de 100 m de avenidas de alto tráfico, resultando en valores muy similares para Cd (0.0220 ± 0.13 mg / Kg y 0.0311 ± 0. 22 mg / Kg), mientras que para Pb el los valores fueron muy precisos (0.032 ± 0.35 mg / Kg y 0.029 ± 0.20 mg / Kg). Estas mediciones muestran cómo, en sitios cercanos a las actividades humanas, las concentraciones de estos metales pesados están en niveles más altos, lo que representa un peligro para su consumo debido a la bioacumulación en diferentes tejidos humanos.

Palabras clave: metales pesados, humo metálico, contaminación, tráfico vehicular.

Abstract

The aim of this study was to determine accumulation levels of heavy metals like Cadmium (Cd) and Lead (Pb) derived from anthropogenic activities, such as metallic fumes from welding and vehicular traffic, in guava pulp (Psidium guajava) in the city of Cartagena-Bolívar. Samples were divided into three (3) groups according to the proximity of the sources of contamination. In group 1, less than 100 m of metallurgical industries, Cd concentrations in the range of 0.0400 ± 0.33 mg /Kg and 0.0483 ± 0.15 mg/Kg, while Pb values ranged between 0.036 ± 0.22 mg / kg and 0.060 ± 0.01 mg / kg. For group 2, samples were taken in 3 places where no source of contamination was clearly identified, resulting in Cd concentrations 0.0215 ± 0.05 mg / Kg and 0.0260 ± 0.10 mg / Kg, while for the Pb it was only found in one of the samples whose value was 0.035 ± 0.15 mg / Kg. Finally, for group 3, samples were taken at 2 locations located less than 100 m high traffic avenues, resulting in very similar values for Cd (0.0220 ± 0.13 mg / Kg and 0.0311 ± 0. 22 mg / Kg), while for Pb the values were very precise (0.032 ± 0.35 mg / Kg and 0.029 ± 0.20 mg / Kg). These measurements show how, at sites close to human activities, concentrations of these heavy metals are at higher levels, representing a danger for their consumption due to bioaccumulation in different human tissues.
Keywords: Heavy Metals, Metallic Fume, Pollution, Vehicular traffic.

INTRODUCTION

Fruits are a group of foods essential for the health and well-being of humans and animals, especially for their contribution of fiber, vitamins and minerals and substances with antioxidant action (Vitamin C, Vitamin E, beta-carotene, lycopene, lutein, flavonoids, anthocyanins) (Cárdenas-Bustamante et al., 2001; Barbosa et al., 2010; Penningtong & Fisher, 2010; León et al., 2016; Torrenegra et al., 2016; Granados et al., 2017). However, fruits can contain and accumulate a toxic level of heavy metals proceeding from different sources. Metals are found in foods come naturally from the dissolution of rocks, although some of them because of agriculture practices such as use of pesticides or fertilizers, as well as to the epidermal transpiration of contaminated environments.

The group of heavy metals of the greatest risk constitutes those whose concentration in the plant is not toxic for itself, but for man or animals, for example, the cadmium (Cd), cobalt (Co) and Selenium (Se) (Barbosa et al., 2010). Toxicity depends on the dose that is ingested, as well as the quantity excreted; it must be keep in mind that the metallic or elemental form is not usually the most toxic but the ionic form (salts). In humans, the three main routes of entry of heavy metals to the body are: the inhalation either in the form of particles (gas or vapor), in elemental form or as inorganic or organic combinations, the dermal through the skin and the oral when contaminated beverages or foods are ingested (Cárdenas-Bustamante et al., 2001; Bi et al., 2006).

However, these heavy metals can cause chronic adverse effects on the central nervous system, bones and all other organs; Within this group of metals, cadmium and lead are included, which are harmful to human health, even at low exposures (Martínez-Flores et al., 2013; Puello-Silva et al., 2018; Gómez-Marrugo et al., 2018). For these reasons, this project will determine heavy metals such as lead and cadmium in guava pulp (*Psidium guajava*) obtained in the city of Cartagena-Bolívar.

MATERIALS AND METHODS

Collection and sampling

This stage was subdivided into two phases, the first consisted in the collection of the raw material, that is, the pulp of guava (*Psidium guajava*), in three different zones of the city of Cartagena.

Selection criteria. Guava fruits of healthy aspect were chosen in the correct state of maturity, without deterioration or signs of contamination by fungi, pests and mechanical damages.

Exclusion criteria. Guavas (*Psidium guajava*), which were found with mechanical damage or alterations caused by insects or microbes were discarded.

The second phase consisted of sampling according to the specifications of NTC 756 for the sampling of fresh fruits and vegetables.

Heavy metals Pb and Cd were analyzed by atomic absorption spectrometry with air-acetylene flame (EAA), for which guava samples were selected according to their physiological and organoleptic state, discarding those that presented some physical and biological damage, then They classified the samples according to their place of origin and washed (in a general way) with pure water to eliminate the impurities. They were blanched at 80° C for a period of 5 min to eliminate any source of microbial contamination, then the samples were pulped in a COMEK brand pulper of 304 stainless steel and Motor: SIEMENS 2 hp (750 rpm), the samples were packed in plastic bags of low density polyethylene (Ziploc), sealed and labeled with a weight of 250 g and place of origin (this sampling was done according to the parameters established in the current regulations in Resolution 3929 of 2013 and NTC 404).

Preparation of the samples by digestion - Wet way. The Official Mexican Standard NOM-117-SSA1-1994 was used to perform this procedure. Obtained the samples, they were lyophilized in a Labconco brand equipment for a period of 3 hours to then begin the preparation of the samples (NOM-117-SSA1-1994, 1995).

Subsequently, the samples were placed in test tubes and 10 mL of 65% concentrated nitric acid (Suprapur) were added to them to be digested for a period of 16 - 24 hours at room temperature, fundamental time to degrade the organic material. After that period, the samples were heated in a plate at 70° C for 2 hours in an extraction chamber until the digestion process was completed, providing that they did not reach boiling stage.

RESULTS AND DISCUSSION

Table 1 shows the values obtained for the concentrations of Cadmium (Cd) and Lead (Pb) obtained in the fruit pulp. These were divided into 3 groups according to the proximity and source of contamination.

In group 1, 7 samples located less than 100 m from metallurgical industries were taken, yielding Cd concentrations in the range of 0.0400 ± 0.33 mg / Kg and 0.0483 ± 0.15 mg / Kg. Pb values ranged between 0.036 ± 0.22 mg / kg and 0.060 ± 0.01 mg / kg. For group 2, samples were taken in 3 locations where no source of contamination was clearly identified, resulting in Cd concentrations 0.0215 ± 0.05 mg / Kg and 0.0260 ± 0.10 mg / Kg, respectively. On the other hand, the Pb was only found in only one of the samples whose value was 0.035 ± 0.15 mg / Kg. Finally, for group 3, samples were taken at 2 locations located less than 100 m high traffic avenues, resulting in very similar values for Cd (0.0220 ± 0.13 mg / Kg and 0.0311 ± 0.22). mg / Kg), whereas for Pb the values were very precise (0.032 ± 0.35 mg / Kg and 0.029 ± 0.20 mg / Kg).

According to above, the mobility of heavy metals in the soil and thus, absorption by plants, is related to various mechanisms of association of the metals with the solid phase. This association is influenced by different factors such as: soil pH, organic matter content, redox potential, calcium carbonate content and iron and manganese levels (Barbosa et al., 2010).

Table 1. Levels of Cd and Pb concentration in guava pulp

GRUP 1†			GRUP 2††			GRUP 3†††		
LOCATION SAMPLE	Cd (mg/Kg)	Pb (mg/Kg)	**LOCATION SAMPLE**	Cd (mg/Kg)	Pb (mg/Kg)	**LOCATION SAMPLE**	Cd (mg/Kg)	Pb (mg/Kg)
1	0,0477±0,66	0,060 ± 0,01	8	0,0215±0,05	0,035 ± 0,15	11	0,0304±0,10	0,032± 0,35
2	0,0401±0,25	0,055 ± 0,33	9	0,0260±0,10	< DL	12	0,0311±0,22	0,029 ± 0,20
3	0,0482±0,25	0,041 ± 0,05	10	0,0220±0,13	< DL			
4	0,0479±0,50	0,045 ± 0,17						
5	0,0400±0,33	0,048 ± 0,20						
6	0,0483±0,15	0,037 ± 0,25						
7	0,0477±0,20	0,036 ± 0,22						
PERMISSIBLE LIMIT *	0,050 mg/Kg	0,10 mg/Kg		0,050 mg/Kg	0,10 mg/Kg		0,050 mg/Kg	0,10 mg/Kg

† Samples located near (less than 100 m) of metallurgical industries (1 - 7)
†† Samples where no source of contamination is identified (8 - 10)
††† Samples located near (less than 100 m) high traffic avenues (11 and 12)
* Limit permissible for human consumption according to the Regulation of the European Commission No 1881/2006
DL = Detection Limit.

CONCLUSION

As a result of this study, the following conclusion was reached:

In the pulp of guavas (*Psidium guajava*) levels of lead and cadmium were detected. In the case of the concentration of Pb, these do not exceed the maximum permissible levels, which is why the fruit is considered suitable for agroindustrial consumption and processing, taking into account the limits established by EC Regulation 1881/2006 of the Commission of the European Communities. (0.1 mg / kg of lead). While for the case of Cd, the samples near welding processes are very close to the permissible level (0.05 mg / kg of cadmium), which represents a danger to their consumption.

On the other hand, despite the fact that in other sampling points the levels of these heavy metals do not exceed the permissible values, their consumption remains a latent risk, because they are fruit trees located in residential areas, where there is no control over their collection and consumption. Finally, it has been shown that these metals bioaccumulate causing health problems, since they are involved in processes of oxidative stress, endocrine disruption, among others (Flora et al., 2008; Irfan et al., 2013; ATSDR, 2016).

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