TRACE ELEMENTS IN FRUIT AND VEGETABLE
TRACES DE MÉTAUX DANS LES FRUITS ET LÉGUMES
METALLI IN TRACCIA IN FRUTTA E VERDURA

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Abstract

The concentration of six different trace metals [vanadium (V), nickel (Ni), chromium (Cr), lead (Pb), copper (Cu) and cadmium (Cd)] were determined in various fruit and vegetables [peach (*Prunus persica* L.), plum (*Prunus domestica* L.), tomato (*Solanum lycopersicum* L.), courgette or marrow (*Cucurbita pepo* L.) and lettuce (*Lactuca sativa* L.)] provided by diverse farms. Metal distribution was also separately evaluated, in skin and pulp, where it was possible. Their contributions to human daily intake of trace metals were investigated. Atomic absorption spectrometry was used to determine the concentrations of these metals in the fruit and vegetables. All traces of elements tested in peaches and tomatoes were higher in the skin than in the pulp except for Cd in the peaches; all traces of elements tested in plums and marrows were higher in the pulp than in the skin. The concentrations of Pb and Cd in lettuce were 1.3 and 2.7 times above the permissible levels, respectively. It is concluded that the regular monitoring of food trace metals is very important to prevent diseases that depend on their excessive accumulation in the human food chain.
Keywords:: *trace elements; fruit; vegetables.*

Résumé

Les traces de six différents métaux [vanadium (V), nickel (Ni), chrome (Cr), plomb (Pb), cuivre (Cu) et le cadmium (Cd)] ont été évaluées dans différents fruits et légumes [pêches (*Prunus persica* L.), prunes (*Prunus domestica* L.), tomates (ì *Solanum lycopersicum* L.), courgettes (*Cucurbita pepo* L.) et laitues (*Lactuca sativa* L.)] provenant de diverses exploitations agricoles. La distribution a également été évaluée séparément dans la peau et la pulpe, lorsqu'il a été possible. Leur contribution à l'absorption quotidienne humaine de traces de métaux a été étudiée. La spectrométrie d'absorption atomique a été utilisée pour déterminer les concentrations de ces métaux dans les fruits et légumes. Toutes les traces de métaux testées dans les pêches et les tomates se sont montrées plus élevées dans la peau que dans la pulpe, sauf pour le cadmium dans les pêches. Toutes les traces de métaux testées dans les prunes et les courgettes se sont montrées plus élevées dans la pulpe que dans la peau. Les concentrations de plomb et de cadmium dans les laitues ètaient respectivement 1,3 et 2,7 fois plus élevées que le niveaux

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admissibles. Il est conclu que le suivi régulier des traces de métaux dans l'alimentation est très important pour prévenir les maladies causées par leur accumulation excessive dans la chaîne alimentaire humaine.
Mots-clés: *traces de métaux; fruits; légumes.*

Riassunto

I livelli di sei diversi metalli in tracce [vanadio (V), nichel (Ni), cromo (Cr), piombo (Pb), rame (Cu) e il cadmio (Cd)] sono stati determinati in diversi prodotti ortofrutticoli [pesche (*Prunus persica* L.), prugne (*Prunus domestica* L.), pomodoro (*Solanum lycopersicum* L.), zucchina (*Cucurbita pepo* L.) e lattuga (*Lactuca sativa* L.)] forniti da diverse aziende agricole.
La distribuzione dei diversi metalli è stata anche valutata separatamente, nella buccia e nella polpa, dove è stato possibile. Sono stati esaminati i loro contributi nell'assunzione giornaliera. Per la determinazione della concentrazione di questi metalli, nella frutta e verdura è stato utilizzato uno spettrofotometro ad assorbimento atomico.
Tutti gli elementi in traccia testati nelle pesche e pomodori sono risultati più elevati nella buccia che nella polpa fatta eccezione per il Cd nelle pesche; tutti quelli saggiati nelle prugne e zucchine sono risultati più elevati nella polpa che nella buccia. Le concentrazioni di Pb e Cd nella lattuga sono risultate 1,3 e 2,7 volte, rispettivamente, più elevate rispetto ai livelli ammissibili.
Il monitoraggio periodico dei metalli in tracce nel cibo è molto importante per prevenire le malattie che dipendono dal loro eccessivo accumulo nella catena alimentare umana.
Parole chiave: *elementi in traccia; frutta; verdura.*

Introduction

Food safety is a major public concern worldwide. During the last decades, the increasing demand for food safety has stimulated research regarding the risk associated with consumption of foodstuffs contaminated by pesticides, heavy metals and/or toxins (D'Mello, 2003). Fruit and vegetables are important components of the human diet, by contributing protein, vitamins, potassium, calcium, iron, and other essential nutrients generally needed in short supply (Thompson and Kelly, 1990). They also act as buffering agents for acidic substances obtained during the digestion process. However, these plants may contain both essential and toxic elements, such as trace metals, at a wide range of concentrations (Bahemuka and Mubofu, 1999). Metals, such as lead, chromium, cadmium and copper are cumulative poisons. These metals cause environmental hazards and are reported to be exceptionally toxic (Ellen *et al*, 1990). Contamination of fruit and vegetable products with trace metal may be due to irrigation with contaminated water, the addition of fertilizers and metal-based pesticides, industrial emissions, transportation, the harvesting process, storage and/or at the point of sale. Human beings are encouraged to consume more

vegetables and fruits, which are a good source of vitamins, minerals, fiber and are beneficial for health. However, these plants contain both essential and toxic metals over a wide range of concentrations. It is well known that plants take up metals by absorbing them from contaminated soil as well as from deposits on parts of the plants exposed to the air from polluted environments (Khairiah *et al*, 2004; Chojnacka *et al*, 2005). Publicity regarding the high level of trace metals in the environment has created apprehension and fear in the public as to the presence of trace metal residues in their daily food. The public is confused and alarmed about their food safety. Keeping in mind the potential toxicity and persistent nature of heavy metals, and the frequent consumption of vegetables and fruits, it is necessary to analyze these food items to ensure the levels of these contaminants meet agreed international requirements (Radwan and Salama, 2006). The aim of this study was to determine the concentrations of trace metals in selected edible fruit and vegetable products to estimate their contribution to the daily intake of trace metals. Metal distribution was also separately evaluated, in skin and pulp, where it was possible.

Material and Methods

Samples of the edible fruit and vegetable (peach, plum, tomato, marrow and lettuce) were taken from main farms.
All the samples, divided in skin and pulp, were oven-dried at 75°C until constant weight and ground to a fine powder by a Fritsch pulverisette 6 with an agate pocket, to prevent element contamination.
Trace element (V, Ni, Cr, Pb, Cu and Cd) extraction and analyses were carried out in triplicate by atomic absorption spectrometry (SpectrAA 20 Varian) and quantified using standard solutions (STD Analyticals, Carlo Erba). Aliquot of the powdered samples (250 mg) were mineralised in a Milestone Microwave Laboratory Systems (Ethos 900), endowed with temperature control, by a combination of hydrofluoric and nitric acid (HF 50%:HNO3 65%=1:2). After digestion the solutions were diluted by deionised water to a final volume of 50 ml. Accuracy was checked by concurrent analysis of standards (Resource Technology Corporation, Laramie, WY). The recovery was higher than 90 %.
The mean (±SD) concentrations for each trace metal regardless of the kind of fruit and vegetable were calculated and a comparison of this data in the selected samples was studied, and compared with the permissible levels set by the FAO and WHO. Based on the average concentration and the average consumption of edible vegetables, estimates of the amount of each trace metal consumed were calculated.
The correlations were determined using the simple Pearson correlation coefficient. (ANOVA) followed by Tukey test (MINITAB INC 13).

Results and discussion

Table 1 shows the mean concentrations of trace metals in the fruit and vegetable samples and the permissible Pb, Cd and Cr levels (FAO and WHO, 2001). The

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results show that all trace elements tested in peaches and tomatoes were higher in skin than in pulp except for Cd in the peaches; all trace elements tested in plum and marrows were higher in pulp than in skin.
The pulp contamination of fruits and vegetables may be related to pollutants in farm soil, while the skin contamination may depend on air pollution from highway traffic (Igwegbe *et al*, 1992).

Table 1 - *Concentrations of trace metals in fruit and vegetable products (mg/kg dry weight).*

	Peach		*Plum*		*Tomato*		*Marrow*		*Lettuce*	
										*Recom max l for vegetables*[b]
	skin	pulp	skin	pulp	skin	pulp	skin	pulp		
Pb	**0.43**	**0.37**	0.31	**0.45**	**1.65**	**1.33**	**2.87**	**2.13**	**3.31**	*0.3*
V	0.25	0.09	ND	ND	4.09	1.81	8.98	6.78	10.4	*NP*[c]
Cd	0.09	**2.18**	0.12	**0.67**	**0.31**	**0.28**	**0.50**	**3.58**	**1.93**	*0.2*
Cu	12.4	5.79	5.49	6.48	19.3	13.9	22.3	14.9	37.8	*40.0*
Cr	2.07	0.65	0.11	0.46	**11.3**	**6.04**	0.18	0.55	1.65	*2.3*
Ni	2.30	2.92	1.30	1.10	4.16	2.45	8.39	6.92	8.16	*NP*[c]

[a] *ND = Not detected. Levels were below the detection limit -* [b]*Recom max l = Recommended maximum limit;* [b]*Source: FAO/WHO (2001), Joint Codex Alimentarius Commission -* [c]*NP = not provided.*

The concentrations of Pb and Cd in lettuce were 1.3 and 2.75 times above the permissible levels, respectively (tab.2). It is known that a long exposure to lead can cause anemia, colic saturnine until neurotoxic effects like chronic encephalopathy or polyneuritis; cadmium can cause hypertension, higher blood pressure, atherosclerosis and progressive reduction in kidney function.

Table 2 - *Tolerable daily intake (TDI) and esitmation daily intake of trace elements through consumption of fruit and vegetables considering a typical diet (300g of fruit and vegetable per day).*

		Estimated daily intake (µg/day)				
	TDI (µg/day/60 kg b.w.)[a]	*Peach* 	*Plum* 	*Tomato* 	*Marrow* 	*Lettuce* 
Pb	214	13.14	17.65	19.18	21.10	**284.5**
V	NP[b]	—	—	—	—	—
Cd	60	**77.4**	26.28	4.04	35.45	**165.88**
Cu	50-200	23.07	18.04	87.4	5.44	141.82
Cr	NP[b]	—	—	—	—	—
Ni	NP[b]	—	—	—	—	—

[a] *(FAO/WHO, 1993) -* [b]*NP = not provided*

The amounts of trace elements may be hazardous if fruits and vegetables are taken in large quantities. On the other hand the intake is cumulative of that derived by other foods (pasta, meat, milk and their derivatives etc.). Therefore, it is estimated that man can swallow daily contaminants that are near to the weekly limits for chronic hazards. In addition the daily tolerable dose for adults is lower than for childs.

The regular monitoring of food trace metals, therefore, is very important to prevent diseases dependent on their excessive build-up in the human food chain.

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