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Food survey: Levels and potential health risks of chromium, lead, zinc and copper content in fruits and vegetables consumed in Algeria

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ABSTRACT

A food survey was carried out with the aim to investigate the levels of lead (Pb), zinc (Zn), copper (Cu) and chromium (Cr) in various fruits and vegetables sold in Algeria. Concentrations (mg/kg dry wt.) in selected foodstuffs were detected within the following ranges: 4–29.49, 11.17–49, 12.33–39.33 and 3–16.33 for Cu, Zn, Pb and Cr respectively. The food ingestion rate of the selected items was investigated by self-administered questionnaires which were filled by a total of 843 people randomly recruited at the exit of markets. The potential health risk for consumers was investigated by estimating the daily intake (*EDI*) and the target hazard quotient (*THQ*) for each heavy metal. For all foodstuffs, the *EDI* and the *THQ* were below the threshold values for Cu, Zn and Cr while they exceeded the thresholds for Pb (*EDI*: 15.66 μg Pb/kg body weight/day; *THQ*: 4.37), indicating an obvious health risk over a life time of exposure.

1. Introduction

Heavy metal pollution is of increasing concern because of food safety issues, potential health risks, and its detrimental effects on soil ecosystems (Jarup, 2003; Li et al., 2014). For example, lead (Pb) is a non-essential element to the human body, and excessive intake of the metal can damage the nervous, skeletal, circulatory, enzymatic, endocrine, and immune systems of those exposed to it (Jarup, 2003; Li et al., 2014; Radwan and Salama, 2006). Chromium (Cr) is a common heavy-metal contaminant in soil, groundwater and sediments. Usually, Cr occurs in two forms: Cr (III) and Cr (VI). Cr (III) is biologically important to the human body in which it influences sugar and lipid metabolism (Duran et al., 2011). On the other hand, chronic exposure to Cr (III) may result in liver, kidney or lung damage. Cr (VI) is highly toxic to biota and has been determined to be a human carcinogen by inhalation (Liao et al., 2011).

Other metals such as copper and zinc are essential for important biochemical and physiological functions and necessary for maintaining health throughout life (Li et al., 2014; Radwan and Salama, 2006). Even though zinc is an essential requirement for a healthy body, excess zinc can be harmful; indeed, excessive absorption of this element can suppress copper and iron absorption. In human body, free copper causes toxicity, as it generates reactive oxygen species such as superoxide, hydrogen peroxide, and the hydroxyl radical. These damage proteins, lipids and DNA (Brewer, 2010).

Human exposure to heavy metals from air and food has risen dramatically during the 20th century, as a result of an exponential increase in the use of heavy metals in industrial processes and products (Jarup, 2003; Li et al., 2014; Liao et al., 2011; Radwan and Salama, 2006). Therefore, national and international regulations on food quality have lowered the maximum permissible levels of toxic metals in human food (Radwan and Salama, 2006).

The control of heavy metals in foods including fruits and vegetables is of increasing importance. It should be noted that fruits and vegetables are important components of human diet across the world both in terms of quantities consumed and nutritional value (Khillare et al., 2012). They are rich sources of proteins, vitamins, minerals, and fibers and have also beneficial antioxidative effects (Hu et al., 2013; Minkina et al., 2012).

The heavy metal contamination of fruits and vegetables may occur by uptake in roots from contaminated soils and irrigation water as well as from deposits on parts of the plants exposed to the air from polluted environments (Khillare et al., 2012; Minkina et al., 2012; Radwan and Salama, 2006).

Regular surveys and monitoring programs of heavy metal contents in foodstuffs have been carried out for decades in many countries (Ali and Al-Qahtani, 2012; Divrikli et al., 2003; Hu et al., 2013; Khillare et al., 2012; Radwan and Salama, 2006; Song et al., 2009; Tuzen et al., 2007; Wang et al., 2005; Yang et al., 2011). To our

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Table 1
Concentration of Cu, Pb, Zn and Cr (mg/kg dry weight) in fruits and vegetables.

Foodstuffs	Hymidity (%)	Concentrations of metals (mg/kg dry weight)				MCHV[a] (mg/kg dry weight)
		Cu	Zn	Pb	Cr	
Fruits						
Melons	91.01	4.00	16.83	19.17	6.17	46.17
Strawberries	90.50	4.00	22.17	20.67	3.00	49.84
Vegetables						
Green peppers	93.97	5.50	13.50	14.33	4.17	37.50
Zucchinis	89.50	3.83	12.67	18.50	9.00	44.00
Beans	92.85	13.83	19.33	12.33	6.83	52.32
Salad	92.57	4.17	23.50	20.83	4.17	52.67
Beets	87.80	10.17	14.83	16.50	12.33	53.83
Peas	79.83	9.67	17.67	21.67	6.50	55.51
Carrots	83.81	12.00	11.17	23.67	14.00	60.84
Cucumbers	94.56	23.15	25.86	16.08	9.12	74.21
Artichokes	85.24	10.67	39.67	20.00	11.00	81.34
Spinaches	92.33	8.33	49.00	16.67	8.33	82.33
Tomatoes	91.10	9.04	37.34	26.99	14.10	87.47
Potatoes	80.42	29.49	30.34	23.76	12.50	96.09
Onions	89.22	18.33	37.67	39.33	16.33	111.66

[a] Mean concentration of all heavy metals (Cu, Cr, Zn and Pb).

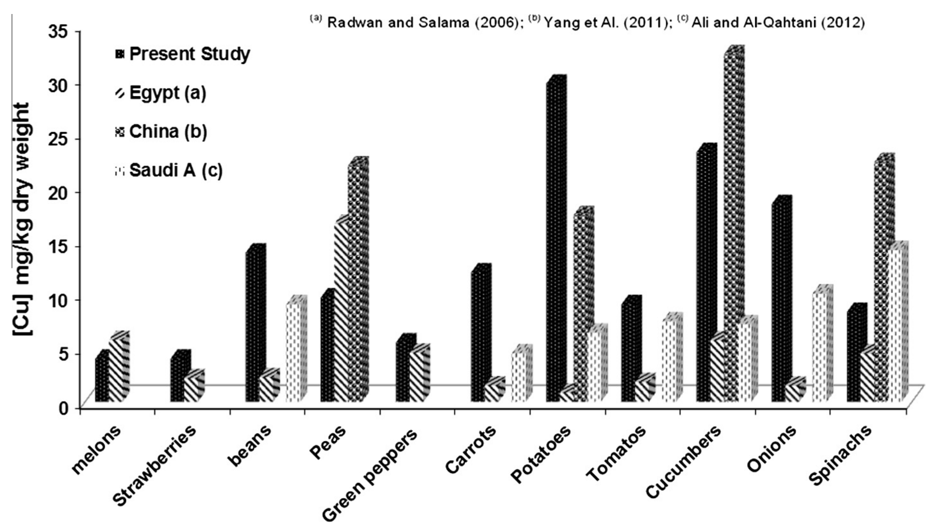

Fig. 1a. Levels of copper in fruits and vegetables from the Algerian markets compared with previously published results from Egypt, China and Saudi Arabia.

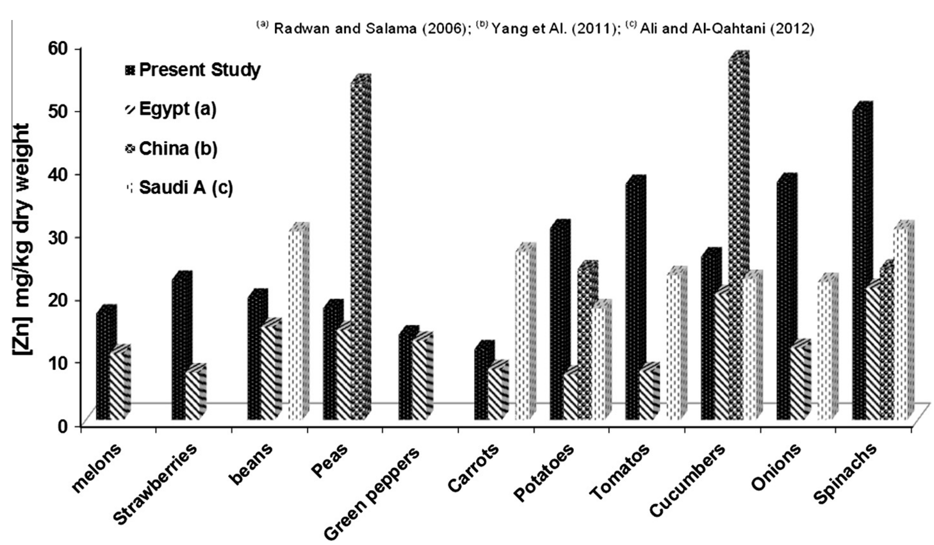

Fig. 1b. Levels of zinc in fruits and vegetables from the Algerian markets compared with previously published results from Egypt, China and Saudi Arabia.