



Evaluation of trace element contents of dried apricot samples from Turkey

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ABSTRACT

The trace and toxic elements (TEs) were determined in apricot samples by flame and graphite furnace atomic absorption spectrometry, prior to microwave-assisted acid digestion. Among all determined TEs, iron was found to be the dominant elemental ion as compared with other TEs in apricots followed by zinc and manganese ions. The concentration of essential TEs were observed in the range of 10.4–80.1, 0.92–6.49, 0.97–8.27, 2.96–12.0 $\mu\text{g g}^{-1}$, 4.76–28.9 $\mu\text{g kg}^{-1}$ and 0.32–0.64 $\mu\text{g g}^{-1}$ for iron, copper, manganese, zinc, chromium and selenium ions, respectively. While the toxic elemental contents were observed in the range of 0.02–0.72, 0.72–3.77, 2.30–5.83 and 0.08–0.22 $\mu\text{g g}^{-1}$ for cadmium, lead, nickel and aluminium ions, respectively. The results were compared with the literature reported values.

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1. Introduction

About 30 elements are recognized as essential to life. Some are required in macronutrient amounts in essentially all forms of life: H, Na, K, Mg, Ca, C, N, O, P, S and Cl. The others occur in trace or ultratrace quantities. Fe, Cu, and Zn are at the top end of this “trace” scale. The other elements required are Li, B, F, Si, V, Cr, Mn, Co, Ni, As, Se, Mo, W, and I. The trace and ultratrace elements most important for human cellular functions are Fe, Cu, Zn, Mn, Co, Cr, V and Se. There are about 4–6 g of iron ion, 2–3 g of zinc ion, and only 250 mg of copper ion in human body. Cobalt is an essential trace element (TE) required for normal metabolism of Vitamin B12. There is one cobalt atom in this vitamin; the latter is present in only 2–5 mg quantity in the human body [1].

Elements such as iron, copper, zinc and manganese are essential elements since they play an important role in biological systems, whereas lead and cadmium are non-essential elements as they are toxic, even in traces [2]. The essential elements can also produce toxic effects when the element intake is excessively elevated. In recent years it has become clear that transition metal such as Cu, Zn, Mn, Cr, Co and Se are essential for normal development and function of human cells.

It has long been known that fruits constitute a rich source of vitamins and minerals [3]. The major part of the edible portion

of fresh fruits contains 75–95% water. Fruits principally contain citric, tartaric and malic acids, with pH varying between 2.5 and 4.5. Other constituents of fruits include cellulose and woody fibers, mineral salts, pectin, gums, tannins, coloring matters and volatile oils [4]. However, in the advent of recent heavy metal contamination of the environment, the analysis of TE in seasonal fruit samples has gained considerable importance due to health considerations. As with many other fruits, numerous investigations on apricot because of the nutritional importance of this fruit have been carried out on focusing mainly on their acids, amino acid, minerals including metals and vitamin contents [3–9].

Kayseri is located in the middle Anatolia Region of Turkey (38.42°N, 35.28°E). Kayseri is an industrial agricultural city in the central Anatolia—Turkey and has a population of one million. The climate in Kayseri is dry with hot summers and cold winters. Temperature ranges between 20 and 40 °C, average values being 30 °C during summer and –5 °C during winter. Various samples (honey, mushroom and spices) have been analyzed with respect to TEs in this region [10–12].

There has been no report, to our knowledge, on the TE levels in apricot samples cultivated in Kayseri. It was therefore necessary to assess the approximate levels of TEs in local fruits grown during summer and consumed in large bulk. This study is important, especially in the advent of the fast industrialization and urbanization whereby serious threats of environmental pollution are on their way, making it still more binding to evolve an abatement program for toxic TEs in edible fruits.

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2. Experimental

2.1. Samples

In this study, 10 samples of apricots were analyzed for their TE content. Apricot samples were harvested from gardens in Kayseri, Turkey, during July 2006. The samples were placed in glass containers and transported to the laboratory. The pits of apricots were separated, and apricots were dried at room temperature for 3 days. The dried samples were homogenized using an agate homogenizer and stored in polyethylene bottles until analysis. The areas of the study were selected from different potential pollution sources and unpolluted areas.

2.2. Reagents

Analytical reagent-grade chemicals were employed in the preparation of all solutions. Doubly distilled deionised water (Milli-Q Millipore $18.2 \text{ M}\Omega \text{ cm}^{-1}$) was used in all experiments. The HCl, HNO_3 and H_2O_2 were of suprapure quality (Merck, Darmstadt, Germany). All the plastic and glassware were cleaned by soaking in dilute nitric acid (1+9) and were rinsed with distilled water prior to use. The standard solutions of investigated analytes for calibration procedure were produced by diluting a stock solution of 1000 mg L^{-1} of the investigated element supplied by Sigma. $10 \mu\text{L}$ 0.015 mg Pd and $0.010 \text{ mg Mg(NO}_3)_2$ as matrix modifier was added to $20 \mu\text{L}$ sample in the determination of selenium ion. $20 \mu\text{L}$ sample and $5 \mu\text{L}$ $\text{Mg(NO}_3)_2$ were used in the determination of aluminium ion.

2.3. Apparatus

A Perkin Elmer Analyst 700 model (Norwalk, CT, USA) atomic absorption spectrometer (AAS) equipped with a deuterium background corrector was used for the determination of TEs. Measurements of Fe, Cu, Mn, Zn and Ni ions were carried out in an air/acetylene flame. The determination of Se, Cd, Pb, Cr and Al ions were performed with graphite furnace atomic absorption spectrometer (GFAAS). Argon as inert gas was used in studies with graphite furnace. Certified reference materials (CRM) were digested in a Milestone Ethos D model closed system microwave oven (maximum temperature 300°C , maximum pressure $1 \times 10^7 \text{ Pa}$). Teflon reaction vessels were used in all digestion procedures. The reaction vessels were cleaned by using 5 mL of concentrated nitric acid before each digestion.

2.4. Digestion procedures

2.4.1. Conventional wet acid digestion (CWD)

An acid digestion method induced by electric hot plate was used in order to discover the total content of TEs and also for comparative purposes. About 0.2 g of triplicate samples of certified sample while 1.0 g of apricot samples, in 50 mL Pyrex flasks and added $5\text{--}16 \text{ mL}$ of a freshly prepared mixture of concentrated $\text{HNO}_3\text{--H}_2\text{O}_2$ (6:2, v/v) and stood for 10 min , then the flasks were covered with watch glass and digested at $60\text{--}70^\circ\text{C}$ for 4 h , till the clear transparent digests were obtained. The final solutions were collected in polyethylene flask, for the determinations of TEs under study by AAS.

A blank extraction (without sample) was carried out through the complete procedures. The concentrations were obtained directly from calibration graphs after correction of the absorbance for the signal from an appropriate reagent blank.

The resulting solutions obtained from both methods were analyzed by FAAS and GFAAS by delivering $10 \mu\text{L}$ aliquots and $10 \mu\text{L}$ appropriate modifiers to the atomizer. The concentrations were

Table 1
The compare performance of CWD and microwave digestion procedure used for the digestion of an apricot sample (numbered 1), $N=3$.

Method	Concentrations ($\mu\text{g g}^{-1}$)									
	Cu	Mn	Fe	Zn	Se	Cd	Pb	Ni	Cr ^a	Al
Microwave digestion	2.42 ± 0.16	7.53 ± 0.38	80.1 ± 3.5	12.0 ± 1.1	0.47 ± 0.02	0.22 ± 0.02	2.50 ± 0.17	3.66 ± 0.14	16.9 ± 1.1	0.10 ± 0.01
CWD	2.25 ± 0.20	7.10 ± 0.65	76.8 ± 6.8	11.7 ± 1.1	0.32 ± 0.03	0.19 ± 0.02	2.36 ± 0.22	3.41 ± 0.30	16.2 ± 1.4	0.09 ± 0.01

^a Cr ($\mu\text{g kg}^{-1}$).

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