Chemical composition of some vegetables

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Abstract. The chemical composition of food refers to the types and amounts of nutrients, such as minerals, vitamins, proteins and others. A microwave-assisted digestion method using $HNO_3 + H_2O_2$ was developed for further determination of minerals Ca, Cu, Fe, K, Mg, Mn, Na, P, Se, Zn in parsley, onions and chives samples by ICP OES. The methodology was validated using the CRM Dolt 5 and SRM 1570a, with agreement between the determined and certified/added concentration values, and RSD of 0,8-7 %. The recoveries ranging from 81 to 120 % were obtained. The results of all minerals concentrations in parsley, onions and chives samples ranged as follows: major minerals (Ca, K, Mg, Na, P) = 172-37834 mg kg^{-1} and trace minerals (Cu, Fe, Mn, Se, Zn) = 2.5-293 mg kg^{-1}.

1. Introduction

Parsley is a flavourful, nutrient-rich vegetable that was first cultivated by the ancient Romans and Greeks for use as a medicine food, according to the “Encyclopaedia of Healing Foods”[1]. It´s a rich source of vitamins A, C and K, folate, potassium, iron, fibber and antioxidant compounds. Onions are an edible vegetable in the allium family, which also includes red onions, yellow onions, spring onions, leeks, ramps, scallions, chives, and shallots. Parsley and onions is a base ingredient that adds flavour to many dishes. In this work were used parsley, onions and chives.

The chemical composition of food refers to the types and amounts of nutrients, such as minerals, vitamins, proteins and others. Minerals are found in the structure of teeth and bones, for example, and play a vital role as a part in many enzymes [2]. Minerals are divided into major minerals (Ca, Mg, K, Na, P and S) and trace minerals (I, Zn, Se, Fe, Mn, Cu, Co, Mo, Cr and B). The major minerals helps to relax and contract the muscles, needed for the formation of protein, important for healthy bones and teeth, needed for proper fluid balance, heart function, while trace minerals are important in maintaining cellular and organ membrane functions, brain function, help to solve the cases of fatigue, a structural part in many enzymes, formation of haemoglobin in red blood cells, needed for energy metabolism, helps to detoxification processes and improves digestion [2].

Many techniques can be used for minerals detection in food, such as ICP-MS, INAA, GF-AAS, ICP OES [3-5]. Inductively coupled plasma optical emission spectrometry (ICP OES) is an analytical technique widely used for the determination of minerals in food matrix, due to high sensitivity, versatility, multi-element analysis and speed of analysis [6-8].

The present work was initiated with the aim to develop a microwave-assisted digestion method for the determination of Ca, Cu, Fe, K, Mg, Mn, Na, P, Se, Zn in parsley, onions and chives by ICP OES.

2. Experimental

2.1. Reagents and standards

Calcium (Ca), copper (Cu), iron (Fe), potassium (K), magnesium (Mg), manganese (Mn), sodium (Na), phosphorus (P), selenium (Se) and zinc (Zn) single element standard solutions (1000 µg mL^{-1}, Inorganic Ventures, USA) were appropriately diluted to prepare standard calibration solutions ranging from 0.05 to 1.5 mg L^{-1} to Cu, Mn,Se, Zn and from 0.05 to 3.0 mg L^{-1} to Ca, Fe, K, Mg, Na, P in a 1% (v v^{-1}) nitric acid (HNO_3, 65%, Merck, Darmstadt, Germany) aqueous solution. Ultrapure water with a resistivity of 18 MΩ cm was obtained using a Biosafer system (Biosafer, Nanjing Safer Co.Ltd, China).

2.2. Samples preparation

The materials obtained were stored frozen in glass Petri plate. The materials were then freeze-dried and transferred to a polyethylene container. The 300 mg mass of each material was weighed directly in polytetrafluoroethylene (TFM) digestion vessels and then 4 mL of HNO_3 concentrated and 0.3 mL of 30 % H_2O_2. The vessels were closed and taken to the microwave oven (DGT 100 Plus, Provecto Analítica, Brazil) for decomposition, according to the following heating program: (I) 330 W for 6 min; (II) 530 W for 3 min; (III) 660 W for 3 min and (IV) 0 W for 3 min. The resulting solutions were diluted up to 20 g with ultrapure water (Biosafer, Nanjing Safer Co.Ltd, China).

2.3. Instrumentation

A Spectro ARCOS ICP optical emission spectrometer (Spectro Analytical Instruments Co, Kleve, Germany), equipped with an axially viewed plasma, was used for the determination of all elements. Sample introduction system was composed by a cross flow nebulizer and a Scott double-pass spray chamber. Instrumental parameters selected for determination were: 1350 W RF power, 12 L min^{-1} plasma flow, 0.9 L min^{-1} auxiliary flow, 0.9 L min^{-1} nebulizer flow, 3 replicates, wavelengths: Ca = 317.933 nm, Cu = 324.754 nm, Fe = 238.204 nm, K = 766.491 nm, Mg = 279.553 nm, Mn = 257.611 nm, Na = 589.592 nm, P = 177.495 nm, Se = 196.090 nm and Zn = 213.856 nm.

2.4. Method validation

Before carrying out the analyses, the method validation process was performed. The first step in method validation was to prepare a written protocol with detailed instructions in the form of analytical procedures and statistical treatment of the obtained data. This protocol assumed that the instrument was previously selected for sensitivity and that the analysts were experienced in analytical methods validation. The second step involved experimental tasks as to prepare and analyse the solutions for each specific parameter defined in the protocol. The following step was the evaluation of the method's performance and to establish the degree of acceptability that is required for each specific parameter. Finally, the appropriate filing of the method's documentation, containing procedures, calculations and all records, was conducted.

The evaluated parameters were matrix effect or selectivity, linearity, quantification limit, precision and accuracy. Two materials were used for evaluated accuracy, CRM Dolt 5 (Dogfish Liver Certified Reference Material for trace Metals and other constituents, National Research Council Canada, NRCC) and SRM 1570a (SRM 1570a, Trace Elements in Spinach Leaves, National Institute of Standards & Technology – NIST). The 400 mg mass of each material was weighed directly in polytetrafluoroethylene (TFM) digestion vessels and then 4 mL of HNO_3 concentrated and 0.3 mL of

30 % H_2O_2. The vessels were closed and taken to the microwave oven, according to the heating program described in 2.2. The resulting solutions were diluted up to 10 g with ultrapure water.

The laboratory where the activities were carried out has a quality system implemented based on the ABNT NBR ISO/IEC 17025 standard [9].

3. Results and Discussion

3.1 *Major minerals (Ca, K, Mg, Na, P)*

The concentrations of Ca, K, Mg, Na and P in the samples are presented in table 1 and are illustrated in figure 1. High and varying concentrations in the samples were observed. The Ca, K, Mg, Na concentrations are higher in parsley samples. The P concentrations are similar in the three types of vegetables studied. A comparison was made between the experimental values and those informed in the book Food Chemistry [10]. For some vegetables, such as tomato or potato cited in the book, Ca concentration range is 64-94 mg kg^{-1}, K = 2420-4180 mg kg^{-1}, Na = 32-33 mg kg^{-1}, P = 220-500 mg kg^{-1}.

Table 1. Major minerals concentrations in the samples.

	onion (mg kg^{-1})	chives (mg kg^{-1})	parsley (mg kg^{-1})
Ca	1764 ± 72[a]	8505 ± 297	10948 ± 296
K	14825 ± 90	25005 ± 316	37834 ± 879
Mg	771 ± 4	2511 ± 90	3120 ± 64
Na	172 ± 13	441 ± 3	1815 ± 15
P	3488 ± 95	3633 ± 88	3605 ± 63

[a] Mean value ± standard deviation (n=3), n = number of independent samples

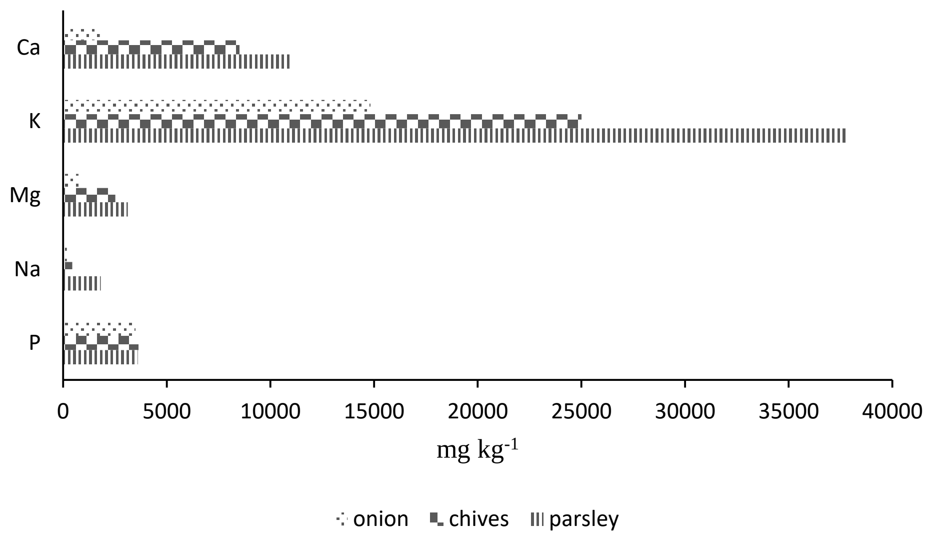

Figure 1. Major minerals concentrations in the samples

3.2 *Trace minerals (Cu, Fe, Mn, Se, Zn)*

The concentrations of Cu, Fe, Mn, Se and Zn in the samples are presented in table 2 and are illustrated in figure 2. The Cu, Fe, Mn, Se concentrations are higher in parsley samples. The Zn concentration is higher in chives samples. The Se concentrations in onion and chives samples were the same.

Table 2. Trace minerals concentrations in the samples.

	onion (mg kg^{-1})	chives (mg kg^{-1})	parsley (mg kg^{-1})
Cu	6.3 ± 0.3	5.59 ± 0.08	22.1 ± 0.5
Fe	22.3 ± 0.8	54 ± 5	293 ± 19
Mn	8.5 ± 0.4	16.5 ± 0.5	51 ± 2
Se	2.5 ± 0.6	2.5 ± 0.2	4.8 ± 0.2
Zn	27 ± 4	52 ± 2	40 ± 1

[a] Mean value ± standard deviation (n=3), n = number of independent samples

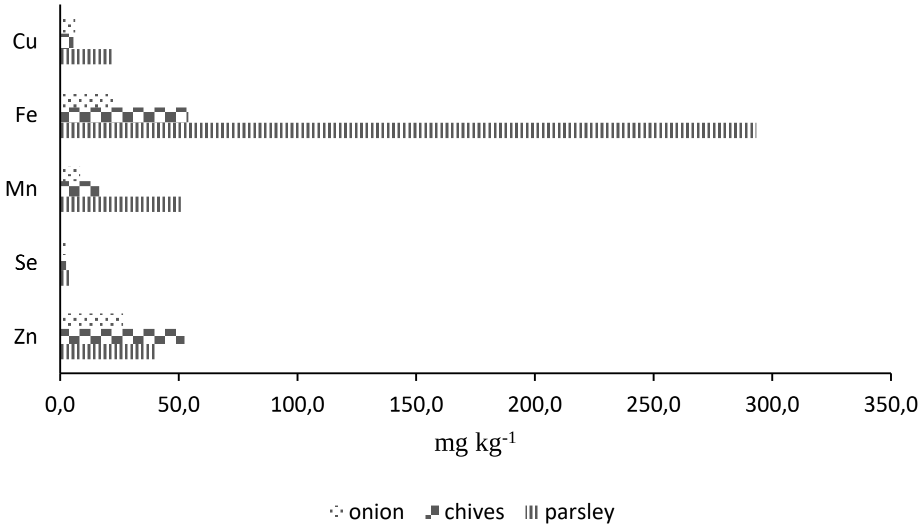

Figure 2. Trace minerals concentrations in the samples.

4. Conclusions

In this paper, a digestion method was used to samples preparation, aiming determine the mineral profile of parsley, onions and chives. The determination of the minerals composition using ICP OES proved to be a simple method and reproducible results. Mineral deficiency is lack of dietary minerals, and these deficiencies can result in several problems in our body. This article can contribute to the evaluation of different kind of food and improve to a mineral control.

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