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Essential elements levels in herbs and their infusions

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Abstract. Health benefits have been attributed to tea consumption since the beginning of its history. The objective of this study was to determine the levels of some essential elements from seven herbs and their infusions. Four essential trace elements (Cu, Fe, Mn and Zn) and a macroelement (Mg) were determined using flame atomic absorption spectrometry (FAAS). Camomile (*Matricaria chamomilla),* dandelion *(Taraxum officinale*), nettle *(Urtica dioica*), tea (*Camelia sinesis)* (Black and green), wormwood *(Artemisia absinthium*) and yarrow *(Achilea millefolium*) were used as material plants in this study. The highest values of essential elements were established in *C sinesis* (Black tea). Studied herbs and their infusions contain essential elements within the safe limits towards human beings.

Keywords: essential trace elements, FAAS, herbs, infusion

1. Introduction

By the development of technology and increase in the importance of time, people have started to consume more processed foods. As a result health problems have increased.

Tea is one of the most popular beverages in the world. At present, there are many herbal tea products widely consumed in Romania and worldwide. Among these products camomile, yarrow, dandelion, black tea and green tea are the most popular herbal tea products consumed for medical purposes or for maintaining good health.

Camomile *(Matricaria recutita)*, yarrow (*Achillea millefolium)*, wormwood *(Artemisia absinthium*) and dandelion *(Taraxum officinale*) belong to Asteraceae family of vascular plants with more than 22.750 currently accepted species, spread across 1620 genera, and 12 subfamilies. Nettle (*Urtica dioica)* is an herbaceous perennial flowering plant from *Urticaceae* family that includes approximately 2600 species, grouped into 54 to 79 genera. Chinese *Camellia sinensis* is the species of plant in the family Theaceae, whose leaves and leaf buds are used to produce Chinese tea.

Herbal tea is generally a polyherbal formulation, made up of different medicinal plants.

Tea leaves and manufactured tea contain alkaloids, proteins, amino acids, enzymes, vitamins and trace elements [1, 2]. Polyphenols are the most biologically active group of herbal tea components which have antioxidative, antimutagenic and anticarcinogenic effects [3-6].

Trace element contents of tea may have both beneficial and adverse effects on human health [7]. Owing to the importance of minerals present in tea many studies were carried out to determine their levels in herbs and their infusions or decoctions [8-13].

Several criteria are used to decide whether an element is essential or not. The following are considered essential elements: cobalt, copper, chromium, fluorine, iron, iodine, manganese, molybdenum, selenium and zinc [14].

The objective of this study was to determine the levels of some essential elements (Cu, Fe, Mn, Mg and Zn) from seven herbs and their infusions.

2. Experimental

2.1. Reagents and solutions

All metal stock solutions (1000 mg/L) were prepared by dissolving the appropriate amounts of the metals or compounds in dilute acids (1:1) and then diluting them with deionised water. The working solutions were prepared by diluting the stock solutions to appropriate volumes. The nitric acid and hydrogen peroxide solutions used were of analytical grade, purchased from Merck.

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2.2. Sampling

The research material comprised seven herbs: *Matricaria chamomilla* (common camomile), *Taraxum officinale* (common dandelion), *Urtica dioica* (common nettle), *Camelia sinesis* (black), *Camelia sinesis* (green) *Artemisia absinthium* (common wormwood), *Achilea millefolium* (common yarrow) and one granulated soluble tea sample. Plant leaves were purchased from a local market and Chinese green and black tea were purchased from a food store in boxes with 20 infusion bags containing aproximatively 1.3 g each. The plants were stored in a dry, dark and cool place.

2.2.2. *Digestion of plant materials*

Aproximately 0.5 grams of each dry plant material was submitted digestion with 8 mL HNO_3 65% and 10 mL H_2O_2 25% at 150^{o}C in a Digesdahl device provided by Hach Company. After the complete digestion the samples solution was filtered and made up to 50 mL with deionized water.

2.2.3. Infusions

Dried aerial parts of the plant (1 g), respectively an infusion bag were added to 100 mL distilled water in a steel kettle after boiling and as allowed to stay for a known interval (10 min), then was filtered with an ash less filter paper. This time parameter (10 min) for infusions was chosen as the optimum time for getting the minerals into the tea from the literature. In general, the minerals that difuse to the tea at higher concentrations at the 15th and 20th minutes were Ag, B, Co, Na and K.

2.3. Method

After bringing the samples in a measurable form, the obtained solutions were analyzed using FAAS instrument from Shimadzu to determine Cu, Fe, Mn, Mg and Zn concentrations. The AA 6200 spectrometer was equipped with air-acetylene flame. The acetylene was of 99.999% purity at a flow rate 1.8-2.0 L/min. The device is based on monofascicol system and is equipped with computerized display and data processing and could be read the concentration value, directly. Monoelement hollow cathode lamps were employed to measure the elements. Analyses were made in triplicate and the mean values are reported The characteristics of elements calibration are presented in **Table 1.**

Table 1. Characteristics of elements calibration curves

Metal	λ, nm	Concentration range (ppm)	Correlation coefficient
Cu	324.7	0.010-1.200	0.9990
Fe	248.3	0.020-4.000	0.9976
Mn	279.5	0.008-1.600	0.9984
Mg	289.2	0 – 15.000	0.9748
Zn	213.9	0.016-0.510	0.9932

The precision of the results (expressed as standard deviation SD and coefficient of variance CV) was determined from three replicates of homogenized samples, giving a good standard and precision for the analytical results of essential elements obtained by FAAS. Good linearity was observed with coefficients of determination, R^2, exceeding 0.9990. Accuracy of the method was evaluated using the standard addition method and was determined on samples at spiking levels of 0.01-0.05 mg/kg from the metals standard solutions. The recovery studies were carried out in triplicate with results between 96 and 101% ranged within the limits imposed by the Horwitz equation (85-110%), indicating the high accuracy of the method. These results reveal that Cu, Fe, Mn, Mg and Zn could be accurately determined by the F AAS method.

3. Results and Discussions

3.1. Essential elements content in herbs

The essential elements levels of dried herbs are listed in **Table 2.**

Copper (Cu) is a micronutrient for plants, but it is also toxic at high concentrations [15]. Cu contents in Chinese and Indian herbs vary over a wide range 9.6 to 20.9 and 1.60 to 35.0 ppm [7], which are higher than values obtained in this study (see Table 2).

Levels of Fe in all the studied dried herbs were within the range of 15.81 – 335.8 ppm being highest in *M chamomilla* and lowest in *A millefolium*. Musa Ozcan et al. [13] reported Fe content in the range 2.94–1295.7 ppm in twenty herbs samples, which are comparable with values obtained for the studied herbs.

Table 2. Essential elements levels of the herbs (mg/Kg dry weight)

Plants	Cu	Fe	Mn	Mg	Zn
M. chamomilla	4.82±0.0013*	335.80±0.0057	16.60±0.0090	874.33±0.030	6.63±0.0051
T. officinale	3.11±0.0010	309.39±0.0005	13.73±0.0040	935.51±0.004	6.67±0.0023
U. dioica	2.92±0.0020	213.94±0.0060	25.59±0.0033	987.10±0.0046	2.87±0.0047
C. sinesis (Black tea)	5.05±0.0008	192.16±00048	331.63±0.0192	860.30±0.0021	7.68±0.0016
C. sinesis (Green tea)	4.90±0.0020	113.83±0.0019	395.75±0.0223	734.72±0.0004	5.22±0.0010
A. absithium	4.37±0.0016	134.03±0.0049	9.97±0.0025	731.00±0.0796	4.33±0.0022
A. millefolium	3.10±0.0010	15.81±0.0002	15.81±0.0002	851.81±0.0002	3.34±0.0013

*±SD-standard deviation

Manganese (Mn) is a plant micronutrient that, depending on its content in the soil and other factors as pH and microbial activity, can achieve levels which are toxic for the plants [16]. In the studied herbs Mn content were situated in the range 9.97 – 395.75 mg/Kg. The highest values were found in C sinesis (Black tea and green tea). These values are higher than those reported by Musa Ozcan in these Chinese herbs [13] , but lower than those found in *C assamica* [11].

Mg content ranged between 731.0 and 987.1 mg/Kg.

In *U. Dioica* the Zn content (2.87 ppm) was very low, as has been already reported in literature [13]. Higher level of Zn was observed in *C sinesis* (Black tea) (7.68 mg/Kg). Anyway this value is lower than those encountered in other herbs [11] and comparable with those reported in the literature for *C sinesis* (Black tea) [13].

The predominant higher concentrations were observed in *C sinesis* (Black tea). Maybe the indiscriminate use of Cu fungicides may lead to the presence of higher levels of Cu content in the black tea (5.05 mg/Kg) [17].

3.2. Essential elements content in tea infusion

The essential elements levels of tea infusions were listed in **Tables 3-7.**

Copper and zinc are required in our diet because they are components of enzymatic and redox systems [8]. The lowest value of Zn was found in granulated soluble tea (0.38 mg/L) and the highest in *C sinesis* (Black tea) (4.75 mg/L).

Table 3. Copper and iron levels of infusions (mg/L)

Plants	Cu	Fe
M. chamomilla	2.86 ±0.0022*	100.04±0.0019*
T. officinale	1.25 ±0.0008	77.70±0.0043
U. dioica	1.42 ±0.0003	39.31 ±0.0028
C. sinesis (Black tea)	2.93 ± 0.0003	9.14 ± 0.0019
C. sinesis (Green tea)	0.94 ± 0.0011	18.30 ± 0.0005
Granulated soluble tea	0.57 ± 0.0015	10.92 ± 0.0023
A. absithium	1.85 ± 0.0011	4.59 ± 0.0027
A. millefolium	1.75± 0.0016	12.66 ± 0.0037

*±SD-standard deviation

Copper is one of the native metals found in tea, central to polyphenol oxidase enzyme. According to Powell et al. [19] the daily dietary intake of Cu through beverages is 2.5 mg day^{-1}. So, the detected levels of copper (see table 3) do not pose serious concern for human health, if consumed with moderation.

Iron is an important element for human body and it is necessary for the formation of hemoglobin [20]. Th level of iron present in studied infusions are from 4.59 mg/L in *A. Absithium* to 100.04 mg/L in *M. Chamomilla.*

Other essential elements present in the infusions are manganese (3.33–162.86 mg/L and magnesium (521.63 – 708.05 mg/L).

Table 4. Manganese and zinc levels of infusions (mg/L)

Plants	Mn	Zn
M. chamomilla	8.99 ±0.0023*	2.51 ±0.0025*
T. officinale	7.44 ±0.0016	3.75 ±0.0018
U. dioica	7.42 ±0.0031	2.57 ±0.0014
C. sinesis (Black tea)	94.08 ± 0.0024	4.75 ± 0.0016
C. sinesis (Green tea)	162.86 ± 0.0045	2.81 ± 0.0026
Granulated soluble tea	4.06 ± 0.0007	0.38 ± 0.0004
A. absithium	3.33 ± 0.0018	0.87 ± 0.0021
A. millefolium	5.56± 0.0012	2.53 ± 0.0011

*±SD-standard deviation

Table 5. Magnesium levels of infusions (mg/L)

Plants	Mg
M. chamomilla	607.56±0.0083*
T. officinale	728.14±0.0054
U. dioica	622.06 ± 0.0045
C. sinesis (Black tea)	521.63 ± 0.0099
C. sinesis (Green tea)	658.46 ± 0.0072
Granulated soluble tea	544.68 ± 0.0035
A. absithium	708.05± 0.0328
A. millefolium	552.79±0.0042

*±SD-standard deviation

In general, the essential elements levels of the herbs and their infusions studied were similar to the literature values. Some discrepencies may be due to the differences in the species, locations, soil properties, harvesting times, geographic parameters and analytical processes [13].

4. Conclusions

The results show that these herbs and their infusions contain essential elements within the safe limits towards human beings.

According to obtained data in this either dry herbal tea or infusions provide a significant amount of essential elements, which confirm the fact that they are important sources of essential elements for human body.

The highest values of essential elements were established in *C sinesis* (Black tea).

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