JAP&T
TPA-Timişoara

Available online at http://journal-of-agroalimentary.ro

Journal of Agroalimentary Processes and Technologies 2021, *27*(4), 453-457

Journal of Agroalimentary Processes and Technologies

Estimation of metals content in medicinal plants

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Abstract

Herbal teas are a popular beverage, that can be prepared very easily (by pouring hot water on various dried herbs). It is very important to monitor and develop a screening methodology for detecting the metal content of both tea plants and herbal tea.

This research aimed to estimate the distribution of metals in different types of herbal teas used in diet therapy. We used atomic absorption spectrometry to determine the concentration trance elements (Fe, Mn, Zn and Cu) of macroelements (Ca and Mg), in various native herbal teas. We used herbal teas collected from Gorj County. These plants are *Tilia cordata*, *Hypericum perforatum*, *Ocimum basilicum*, and *Rosa canina*.

The study aimed at the determination of the mineral composition of medicinal herbs for evaluation of the coverage of the recommended daily intake of mineral elements by tea. The concentration of these bio- minerals in medicinal herbs shows significant variations determined by the nature and type of herbal tea and bio-elements investigated.

Keywords: biominerals, metals, atomic absorption spectrometry, medicinal herbs

1. Introduction

Romania is a European country with a rich diversity of plants due to climatic conditions and geographical position (it is situated in South East of the Europa continent). In Romania and in the world, tea is one of the very popular beverages. It is known that for its medicinal properties, tea was first consumed in China (about 5,000 years ago). Nowadays, tea is widely recognized for its health benefits, as well as for raising public awareness of the high content of biologically active compounds (such as flavonoids, polyphenols, vitamins, minerals, etc.). from herbs and plant extracts [1]. Herbal teas are used as therapeutic vehicles in many forms of traditional medicine.

Medicinal plants are known for their large variety of herbal teas with particularly beneficial effects on nutrition and health.

The beneficial effects of teas are due to the diversity of biologically active compounds that are part of the composition of medicinal plants. Among the biologically active substances are polyphenols, flavonoid compounds, tannins, vitamins, oils, flavors, alkaloids, etc. [2-6].

Compounds of medicinal herbal (such as biologically active compounds, mineral, etc.) have contributed and continue to contribute to the development of new therapeutic strategies [4,6,18].

Bioelements are importance to both plants and living beings (people and animals). in living organisms (plants, animals, etc) mineral/ elements are found as ions, organic and inorganic salts, or are accumulated into various organic compounds [1-4,7,8]. The minerals are classified into macro, micro and ultra microelements, vs. their content ratio in plant.

This research was aimed to estimate the distribution of some metals in different types of herbal teas used in diet therapy. We used atomic absorption spectrometry in order to determine the concentration

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of bio-macroelements (Ca, Mg), and trance elements (Mn, Fe, Zn and Cu) in various indigenous herbal teas. The studied medicinal herbs were collected from county Gorj. These medicinal plants are little leaf linden (*Tilia cordata*), perforate St John's-wort (*Hypericum perforatum*), basil (*Ocimum basilicum*) and dog rose (*Rosa canina*). The study aimed at the determination of the mineral composition of medicinal herbs for evaluation of the coverage of the recommended daily intake of mineral elements by tea.

2. Material and methods

Collection and preparation of herbal samples. In this work we used herbal teas were collected from county Gorj (in 2017). These medicinal herbals used in our research are shown in table 1.

The samples were transferred to our laboratory after harvest. The plants were selected according to uniformity of shape and color, and then were then dried at 25-55^{0}C and stored in paper bags at 20 °C until analysis. After washing, the plants were dried in a shady place and then were transformed into powdered. The materials in the form of powders were used in the analysis.

Reagents and Apparatus. In this study we used reagents were purchased from Merck (Germany). Aqueous standard solutions of Ca, Mg, Fe, Mn, Zn, and Cu were prepared by appropriate dilution of 1,000 gL-1 stock solutions (Merck Darmstadt, Germany). We used HNO_3 (65%) and hydrogen peroxide H_2O_2 (25%) to disaggregate the samples.

For determination of the concentration of mineral (elements) in herbs used spectrophotometer (air-acetylene flow) CONTR AA 300 endowed with a soft. The digestion was done in system 6-1007 Digester (provided by Tecator).

Determination of total concentration of elements in herbs. The determination of the biomineral composition in herbal teas occurred in several stages: dried and homogenized samples, mineralising and digestions herbal teas in nitric acid (65%) hydrogen peroxide H_2O_2 (25%) at 150^{o}C and determining mineral absorbance through spectrophotometry. We were used system 6-1007 Digester (provided by Tecator). In the next steps, the samples solution was filtered and brought to a constant volume (50 mL) with deionized bidistilled water, and then, submitted for analysis. The absorbance of the sample was measured by atomic absorbance spectroscopy.

Statistical analysis. Each determination was performed three times (in triplicate), then were calculated the arithmetic mean of these three separate determinations. For statistical analysis of the data were used the program Microsoft Excel.

Table 1. Herbal medicinal plants used in research

	Sample abbreviation	**Plant**	**The Latin name of the plant (family)**	**Parts of plants with medicinal properties used in research**
1	TC	Littleleaf linden	*Tilia cordata*	Littleleaf and flowers linden
2	HP	Perforate St John's-wort	*Hypericum perforatum*	Stems with leaves and flowers
3	OB	Basil	*Ocimum basilicum*	Stems with leaves and flowers
4	RC	Rosehip, dog rose	*Rosa canina*	Fruits

Table 2. Medicinal plants - remedies used in folk practice

Plant *(The Latin name of the plant)*	**Remedies used in folk practice**
Littleleaf linden *(Tilia cordata)*	• Soothing (decreases nervous tension, anxiety, and helps sleep). • Colic - babies • treatment of colds and coughs
Perforate St John's-wort *(Hypericum perforatum)*	• Improve ball operation • elimination of water retention, favouring weight loss. • treating insomnia
Basil *(Ocimum basilicum)*	• cold, flu, headache, but also fever, stress or otitis
Rosehip *(Rosa canina)*	• relieving the symptoms of flu, cold, and cough.
Chamomile *(Matricaria chamomilla)*	• For any kind of suffering (called the plant of Heaven) • Baby colic, hot or colds compresses (on wounds, conjunctivitis on the eyes) • Calming / soothing for the stomach and gastritis

Table 3. The concentration of Ca, Mg, Fe, Mn, Zn and Cu (mean values) in medicinal plants

Samples	Biomineral contents					
	Ca	**Mg**	**Cu**	**Zn**	**Mn**	**Fe**
	$g \cdot kg^{-1}$ dry weight		$mg \cdot kg^{-1}$ dry weight			
TC	16.12	3.12	10.11	33.43	83.79	9.76
HP	7.11	2.91	8.92	60.81	154.23	173.23
OB	16.3	8.09	15.05	21.84	59.12	57.15
RC	12.4	2.93	6.89	15.12	30.98	51.37

Note: DW = dry weight of the sample (herbs)

3. Results and discussions

Tea consumption is part of people's daily routine, as a daily drink and as a therapeutic remedy in many diseases. The use of plants for the treatment of diseases is closely related to human evolution, in all strata and social periods. Phytotherapy (the use of medicinal herbs) is part of popular medicine, which is based on the knowledge of different users, populations, and professionals. In Oltenia region, plants are used for different diseases. The choice of the plants studied was based on data on the use of teas in traditional medicine in various diseases. These data have been collected from the locals over time [9].

Below are some of the conditions that can be treated or alleviated using various teas. A schematic presentation of these remedies is given in the table 2.

Linden tea (*Tilia cordata*), is used as a sedative because it reduces nervous tension, anxiety, and also helps with sleep. It is recommended even for very active children. It is used as a remedy for colic in babies. Little-leaf linden tea is also used to treat colds and coughs.

Chamomile (*Matricaria chamomilla*) is popularly called the plant of Heaven, it cures suffering of any kind. It is used for any disease. This tea is used as a remedy for colic in babies. It is also used as a sedative for the stomach, especially in the case of gastritis. Externally, it is used in the form of hot or cold compresses (on wounds, conjunctivitis on the eyes) [1].

Perforated St. John's wort (*Hypericum perforatum*) is used in the form of tea to improve bile function, especially in the prevention of biliary dyskinesia and cholecystitis. St. John's wort supports blood circulation and helps eliminate water retention, while also promoting weight loss.

St. John's wort tea is also very good for treating insomnia (scientific explanation, because it increases the production of melatonin, the hormone that stimulates deep sleep).

Tea made from basil (*Ocimum basilicum*) is a natural adjuvant for colds, flu, headaches, but also for fever, stress, or otitis.

Rosehip, dog rose (*Rosa canina*) rosehip tea is a natural treatment for the flu, cold and cough symptoms.

The results of the analytical characterization of herbal teas of cations content are displayed in Table 3.

Analysing our data from table 3 and figures 1 and 2, it can see that the distribution of macroelements in the studied medicinal herbs is randomly, having values with large variations, ranging between 2.91 g/kg (Mg, in Perforate St John's-wort, HP) and 16.3 g/kg (Ca, in basil - OB) , very close value, 16.13 g/kg have Ca in Littleleaf linden, TC. These data are depending on the species of plant and on the element analysed nature.

The content of calcium in plant increase from Perforate St John's-wort (HP) to OB *(Ocimum basilicum)*: HP<RG< TC< OB. The magnesium content increase creases in the following order HP< RC<TC<OB.

From table 3 and figure 1 and figure 2, it can see that the distribution of micro-bioelements in the studied medicinal herbs is random, having values with large variations, ranging between 6.89 mg/kg DW (Cu, in rosenship - RC) and 173.23 mg/kg DW (Fe, in Perforate St John's-wort, HP).

The important bioelements represented are Ca and Mg. Values of the analyzed microelements concentrations were found to be much lower, thus for copper the mean concentration in the plant was in the range between 6.89 mg/kg and 15.05 mg/kg; for zinc, the concentration in the plant was in the range 15.12 – 60.81 mg/kg; for iron, the mean concentration in the plant was in the range 9.76 – 173.43 mg/kg DW; for manganese, the mean

concentration in the plant was in the range between 30.98 and 154.83 mg/kg DW.

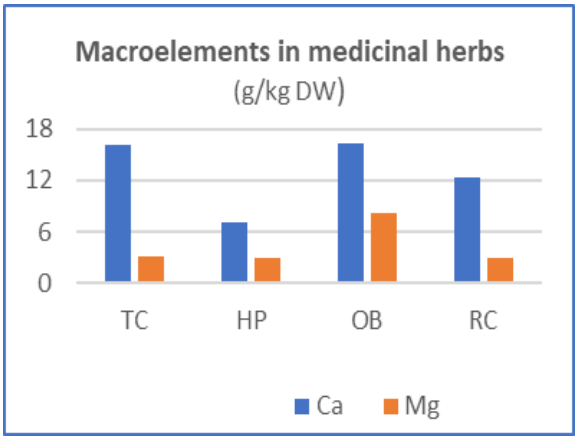

Figure 1. Macroelements content in medicinal herbs

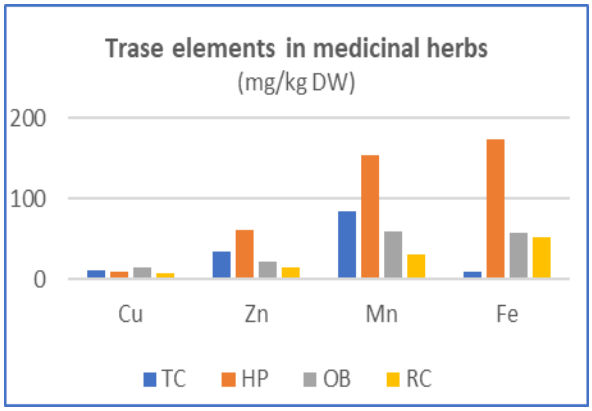

Figure 2. Trace elements content in medicinal herbs

These differences in our data are confirmed by data from the literature. In the literature the values of the total content of elements vary depending on the plant species, the nature of the minerals, as well as a set of factors such as climatic conditions and soil, storage mode, etc.

For medicinal plants HP (*Hypericum perforatum)* and RC (*Rosa canina*) the average concentration in bioelements increases from copper to iron as follows: Cu <Zn <Mn <Fe <Mg <Ca. For basil, OB we have the following variation of the concentration in minerals Cu <Zn<Fe <Mn<Mg <Ca. Instead, for linden – TC we have the following variation of the concentration in minerals Fe <Cu <Zn< Mn<Mg <Ca.

If we analyse the content of an element in different plants, we can see that in the case of calcium the highest content is in basil OB (with a value of 16.3 g/kg DW) varying in the series CO < MC < MP < AM <PL. Content of magnesium increase in the series HP < RC < TC < OB.

For all plants, the highest concentration is found in calcium, followed by magnesium.

This information on the metal content of medicinal plants provides only primary information. This primary information may also be accompanied by data on the minerals (macro and microelements) content of the soil from which these plants originate.

Only minerals from infusions (teas) are available to the body. That is why in our next studies (further our studies) we will focus on the determination content of metals in infusions (teas) but also on the content of metals in the soil.

These studies are important to have an overview of the content of metals in plants and then to determine the extraction coefficient of each element of the plant in the aqueous infusion - tea. Our data can be correlated with those in the literature. The concentrations of metals in medicinal plants are similar to those of the studies from literature [10-17], where the content of metals is approximately in the same concentration range. There are small differences from the data in the literature. The differences can be caused by the climatic conditions, the harvest period, the environmental conditions, etc.

4.Conclusions

Our experimental data are largely consistent with those in the literature. Differences can be caused by climatic conditions, harvest period, environmental conditions, etc.

This work are important to have an overview of the content of metals in plants and then to determine the extraction coefficient of each element of the plant in the tea (the aqueous infusion).

For seeing what the content of elements is available to the body it is necessary to be performed their infusion of plants in hot water – teas. The tea can bring the intake (macro- and micro-) bio-minerals to the human body.

Biominerals from infusions are available to the body. That is why in our next studies we will focus on the determination content of metals in infusions (teas).

Thus, the first step was to determine the content of elements in medicinal plants and then to determine the content of bioelements in infusions of these plants.

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human or animal subjects (if exist) respect the specific regulation and standards.

Scientific material support for the didactic activity within the Faculty of Food Engineering, Banat's University of Agricultural Sciences and Veterinary Medicine "*King Michael I of Romania*" – Timișoara

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