



# PHYSICAL CHEMISTRY 2004

## *Proceedings*

*of the 7<sup>th</sup> International Conference  
on Fundamental and Applied Aspects of  
Physical Chemistry*

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## TRACE AND MINOR ELEMENTS DETERMINATION IN SOME HERBAL DRUGS BY FAAS

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### Abstract

In this paper trace (Cu and Zn) and minor (Mn and Fe) elements in some herbal drugs originating from the plants of the family *Asteraceae* were determined by flame atomic absorption spectrometry. Chamomillae flos, Milefolii herba and Absinthii herba were analyzed taking into account their importance in phytotherapy in different diseases and disorders and the essentiality of mentioned elements for plants life cycle. Validation of proposed method was performed by using CRM, NIST 1573a.

### Introduction

Herbal drugs, originating from the plants of the family *Asteraceae*, also present in a few European pharmacopeias, are of special importance in phytotherapy widely and usually used in supportive therapy for certain digestive and skin disorders. There are many literature data regarding to the numerous active compounds (essential oils, sesquiterpene lactones, alkalamides, tannins, flavonoides, sterols, biogene amines etc.) and effectiveness but there is a lack of valid information concerning trace and minor elements determination. Copper, Zn, Mn and Fe are essential for normal growth of plants, their protection against plant viruses, immunity and the completion of the life cycle [1]. Therefore this paper is dedicated to the determination of total element content in samples.

### Experimental

*Solutions and reagents* Standard solutions were prepared by dilution of stock solutions (1000mg/L) with 1M HCl. HCl and HNO<sub>3</sub> were purchased from Merck and were of reagent grade quality. For preparation of the solutions double distilled water was used.

*Sample preparation* Accurately weighted samples (~ 1 g each) were slightly heated on a hot plate at 100 - 120 °C, for 15 min, then placed into a furnace and further heated at 500 °C for 2 hours. After cooling, 10 drops of double distilled water and then 4.0 mL of 8M HNO<sub>3</sub> were added into each sample, slightly heated on the hot plate to dryness then placed in the furnace at 500 °C, for 1 hour. After cooling, 10mL of 6M HCl was added in each sample and the contents were quantitatively transferred into 50mL volumetric flasks.

*Instrumentation* Samples were analyzed for Cu, Zn, Fe and Mn by flame atomic absorption spectrometry using Perkin-Elmer Model 5000. The operating parameters and

the analyte characteristics are given in Table 1. The signals were measured with deuterium background correction at optimal flame (air-acetylene) heights.

**Table 1.** Operating conditions and analyte characteristics

Element	$\lambda$ [nm]	Slit [nm]	Flame type	Sensitivity [ $\mu\text{g/ml}$ ]	Linear range [ $\mu\text{g/ml}$ ]
Cu	324.7	0.7	A-Ac	0.030	5.0
Zn	213.9	0.7	A-Ac	0.011	1.0
Mn	279.5	0.2	A-Ac	0.030	2.0
Fe	248.3	0.2	A-Ac	0.040	5.0

## Results and Discussion

The composition of environmental samples varies from purely inorganic to purely organic, but generally there are an intermediate combination of these extremes. Such examples are plants. Sample preparation i.e. total mineralization and dissolution, as the most critical points, cannot be achieved in one step using single reagent, but often several steps and several reagents are necessary. Among dry ashing and wet digestion procedures [2-4] there are many advantages and disadvantages as well. First procedure, applied in this work has the biggest advantage due to the possibility of ashing large sample amount and dissolving the resulting ash in a small volume of acid allowing the preconcentration of trace elements in the final solution. Temperature used in the preparation procedure is very important and 450 - 550<sup>0</sup>C can be tolerated even for volatile elements. Increasing of temperature must be very slow to avoid any local hot spots or self-ignition of the sample and much loss as well [2].

FAAS offers a detection power ranging between  $\mu\text{g/l}$  and  $\text{mg/l}$  depending on the element considered and also enables cost-benefit analysis [4]. For elements determination an external calibration method was applied and the result of regression and correlation analysis are presented in Table 2.

**Table 2.** Statistical analysis of the experimental data (x – concentration,  $\text{mg/L}$ , y – absorbance, Sa, Sb and  $S_{y/x}$  – standard error of intercept, slope and calibration line)

Element	Calibration line	r	Sa	Sb	$S_{y/x}$
Cu	$y = 0.00071 + 0.04160x$	0.99995	0.00128	0.00041	0.00146
Zn	$y = 0.00311 + 0.12916x$	0.99882	0.00252	0.00444	0.00334
Mn	$y = 0.00017 + 0.03950x$	0.99997	0.00037	0.00029	0.00041
Fe	$y = 0.00370 + 0.02538x$	0.99908	0.00437	0.00077	0.00579

The validity of whole analytical procedure is also controlled by using certified reference material (NIST 1573a - Tomato leaves) in order to ensure that there was (or no) contamination and/or losses. The analytical results are shown Table 3.

**Table 3.** Results [mg/kg] for certified reference material NIST 1573a (Tomato leaves)

Element	Found <sup>a</sup>	Recommended value <sup>a</sup>	% Recovery
Cu	4.26±0.29	4.70±0.14	90.64
Zn	29.42±0.64	30.9±0.7	95.21
Mn	246.18±1.72	246±8	100.07
Fe	338.98±0.56	368±7	92.11

<sup>a</sup> Mean ± standard deviation

It can be noticed that Mn was fully recovered; Zn has good recovery as well. Poorer recoveries for Fe and Cu respectively, are possible consequence of the influence of the particular plant matrix, probably in relation to the binding of analytes with the invisible fine particles of insoluble residue.

The whole procedure was applied for determination of Cu, Zn, Mn and Fe in herbal drugs and obtained results, expressed on a dry weight basis, are shown in Table 4.

**Table 4.** Concentration of elements [mg/kg] in analyzed herbal drugs

Plant	Herbal drug	Cu <sup>a</sup>	Zn <sup>a</sup>	Mn <sup>a</sup>	Fe <sup>a</sup>
Matricaria chamomilla	Chamomillae flos	10.89±0.58	29.16±0.64	48.98±2.76	253.27±0.02
Achillea millefolium	Milefolii herba	7.53±0.30	18.84±0.32	60.92±2.62	103.12±1.50
Artemisia absinthium	Absinthii herba	12.25±0.01	31.70±0.96	36.20±0.38	172.55±0.16

<sup>a</sup> Mean ± standard deviation

The concentration of measured elements decreases as follow: Fe>Mn>Zn>Cu. The differences in concentrations of those elements are attributed to the differences in botanical structure of particular part and their mobility within the plant [1].

## Conclusion

Chamomillae flos, Milefolii herba and Absinthii herba, as herbal drugs of special importance in phytopharmacy were the subject of this work. Copper, Zn, Mn and Fe were determined by applying FAAS after the appropriate sample preparation procedure. Validation of the whole procedure was performed by using certified reference material NIST 1573a – Tomato leaves.

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