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Determination of selected microelements in polish herbs and their infusions

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Abstract

Ba, Cd, Cr, Cu, Fe, Ni, Pb and Zn were determined in birch leaves (*Folium Betulae*), dandelion roots (*Radix Taraxacae*), hawthorn blossom (*Inflorescentia Crataegi*) and their infusions by graphite furnace atomic absorption spectrometry (GFAAS) after microwave digestion of plant samples. Infusions were made from herbs according to prescription for patients, provided by the producer of medicine on the package. The results obtained were compared with daily requirements for each element. Results show high content of cadmium in the medicinal plants analyzed. The highest level in infusions was observed for Ni and Zn (over 90% of the total element concentration for Ni and in most cases over 50% for Zn), and the lowest for Cd and Pb. The calculated daily intake of majority of the analyzed elements was very low (under 1% of daily requirements).

Keywords: Microelements; Herbs; GFAAS; Dietary intake

1. Introduction

A World Health Organisation (WHO) survey indicated that about 70–80% of the world population rely on non-conventional medicine, mainly of herbal sources in their primary healthcare (WHO, 2002). In recent years, we have witnessed the increasing growth in popularity of over-the-counter (OTC) drugs, health foods, nutraceuticals and medicinal products from plants or other natural sources in developed countries. Phytotherapy has a very long tradition and has become popular in the history of humanity and botanical medications. People are not satisfied with their orthodox medical (OM) treatment and the use of medicinal herbs to relieve and treat many human diseases is increasing around the world since they are usually not aggressive and do not have severe side effects. In additon, interest in the chemical composition of medicinal herb products is growing because of ongoing developments in nutrition and in biochemical surveying and mineral prospecting. Even though medicinal herbs are often promoted as natural and therefore harmless, herbal remedies are, by no means, free from adverse effects. The vast majority of them are unlicensed and are not required to demonstrate efficacy, safety or

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quality. Over the past decade several news-worthy episodes in developed communities have indicated adverse effects, sometimes life threatening, allegedly as a consequence of taking OTC herbal products or traditional medicines from various ethnic groups. These OTC products may be contaminated with pesticides, microbial contaminats, heavy metals, chemical toxins and adulterated with orthodox drugs. Excessive or banned pesticides, heavy metals and microbial contaminants may be related to the source of these herbal materials, if they are grown in a contaminated environment or during collection of these plant materials. Chemical toxins may come from unfavourable or wrong storage conditions or chemical treatment associated with storage. The presence of orthodox drugs can be related to the unprofessional practice of manufacturers (Chan, 2003). Plant constitute is an important link by the transfer of trace elements from soil to man. The level of essential elements in plants varies, the content being affected by the geochemical characteristics of a soil and by the ability of plants to selectively accumulate some of these elements. Bioavailability of the elements depends on the nature of their association with the constituents of a soil. Plants readily assimilate elements through the roots. Additional sources of these elements for plants are rainfall, atmospheric dusts, plant protection agents and fertilizers that can be absorbed through the leaf blades (Łozak et al., 2002).

There are however, no standards for medicinal raw plant materials which establish a permissible level of metals in such materials. The World Health Organization mentions maximum permissible levels in raw plant materials only for arsenic, cadmium and lead, amounting to 1.0, 0.3 and 10 mg kg^{-1}, respectively (WHO, 1998). Plants used in therapeutics should be picked in areas free of any contamination sources. However, as can be seen from the literature (Naithani, Kakkar, 2006) medical raw plant materials differ significantly with respect to the content of metals. The concentration of heavy metals is one of the criteria according to which raw plants can be used for the production of medicines. Due to the importance of the mineral and trace elements present in medicinal herbs, several studies have been carried out to determine their levels by using atomic absorption spectrometry (AAS), inductively coupled plasma-mass spectrometry (ICP-MS), inductively coupled plasma-atomic emission spectrometry (ICP-AES), electrochemical methods, neutron activation analysis and total reflection X-ray fluorescence (Adeloju and Young, 1995; Adamo et al., 2003; Basgel and Erdemoğlu, 2006; Reimann et al., 2001; Tüzen, 2003).

The aim of this work was to determine the content of some possible toxic elements in *Taraxacum officinale* (dandelion), *Betula* sp. (birch), *Crataegus* sp. (hawthorn) and in the infusions prepared from these plants. These plants can accumulate some heavy metals (e.g. Cd) and are commonly used in Poland for tea preparation. Estimation of the amount of elements released from plants into the water extracts can serve as a surrogate for calculation of potential health risk.

2. Experimental

2.1. Materials

Samples of *T. officinale* (dandelion), *Betula* sp. (birch), *Crataegus* sp. (hawthorn) were supplied from retail pharmacies located in Warsaw. The samples used normally for tea preparation were not homogenous, with particle size approximately 0.5 to 5 mm. Five samples of each medicinal plant, produced by different manufacturers if available, were analyzed.

Analysis of two certified reference materials: Tea Leaves (INCT-TL-1) and Mixed Polish Herbs (INCT-MPH-2) was performed for quality assurance purposes.

The following reagents were used: standard solutions of Ba, Cd, Cr, Cu, Fe, Ni, Pb and Zn at a concentration of 1 mg ml^{-1} (Merck), concentrated nitric acid of purity suitable for ICP-MS (Merck), redistilled water additionally purified in the Nanopure Deionization system (Barnstead), and argon of 99.99% purity (BOC Gazy).

2.2. Apparatus

The following apparatus was used: a microwave digestion system (Plazmotronika, Wroclaw, Poland), and an Avanta Ultra Z atomic absorption spectrometer equipped with a graphite furnace (GBC Scientic Equipment Pty, Ltd., Dandenong, Australia).

2.3. Procedure

To address the problem of sample inhomogeneity (the raw material was not homogenized by grinding in order to minimize sample contamination), 1.0 g of the raw plant material was placed in PTFE crucibles and 5 ml of concentrated nitric acid was added. After 24 h open pre-mineralization, microwave digestion was performed in a closed system. The microwave digestion program is presented in Table 1.

The digestion solutions were transferred into volumetric flasks and made up to 100 ml with water. The loss of mass after drying (moisture content) was also determined according to the procedure given in Polish Pharmacopeia VI (lost of mass by drying to constant mass at 105 °C).