

ZINC/COPPER RATIO IN THE MEDICINAL PLANTS

Zorica Hodžić, Aida Crnkić, Aldina Kesić, Mirzeta Saletović
University in Tuzla, Univerzitetska no. 4;
75 000, Tuzla, Bosnia and Hercegovina

ABSTRACT

Zinc and copper, two essential trace minerals, perform important biochemical functions and are necessary for maintaining health throughout life. Deficiency as well as excess in either nutrient can produce a variety of biochemical and physiologic changes and has been implicated in the etiology of chronic disease. Zn/Cu ratios > 16 have been associated with increased risk of cardiac abnormalities. The aim of this study was to determine the content of copper and zinc in medicinal plants (Mellisa officinalis, Salvia officinalis, Sambucus nigra, Rosa canina, Crataegus monogyna, Hypericum perforatum, Tilia cordata, Teucrium montanum, Calendula officinalis) and their extracts, and to examine the correlation in ratio Zn/Cu and antioxidant activity of the extract samples. Values of copper and zinc in the dry matter of medicinal plants and extracts were within tolerable limits (Zn: 17,0-64,8 mg/kg; 1,87-6,73 mg/L; Cu: 4,2-12,2 mg/kg; 0,39-0,89 mg/L). The ratio of Zn/Cu in the extracts is ranged from 3.28 (Mellisa officinalis) to 6.74 (Calendula officinalis). The highest value of antioxidant activity had Melissa officinalis extract. A negative correlation was confirmed between the Zn/Cu values and antioxidant activity in extracts ($r = 0,940$).

Keywords: copper, zinc, antioxidant activity, medicinal plants

1. INTRODUCTION

Importance of medicinal plants is best seen in the fact that two-thirds of the world's population uses medicinal plants as a major source for the treatment of various diseases.[1] Extracts (tea) is one of the most popular and the most consumed beverage in the world.[2] Trace elements play an important role in the formation of the active compounds in medicinal plants.[3] Average zinc content in plants is 20-100 mg/kg of dry matter. Zinc (Zn), an essential trace element, is important in numerous critical biochemical processes since it's a cofactor in about 300 metalloenzymes including Cu, Zn-superoxide dismutase, a critical cytoplasmic antioxidant enzyme. Zinc may stimulate the immune system, possibly through its antioxidant properties and protect sulfhydryl groups (-SH) from oxidation.[4] Most zinc is in: shells, meat, legumes and grains.[5] Natural copper content in plants is 2-20 mg/kg dry matter. Based on numerous studies showed that a large number of people take a lot less than the recommended amount of copper. It's mostly older people, and vegetarians.[6] The largest amounts of copper are found in: nuts, grains, liver, chocolate and shellfish.[5] Copper (Cu) could be a potential inducer of LDL oxidation. On one hand, Cu has the ability to oxidize LDL in vitro.[7] On the other hand, it is a constituent of Cu, Zn-SOD which is involved in preventing oxidative injury. In addition, caeruloplasmin, a multifunctional protein which contains most of the Cu in blood, is thought to possess antioxidant functions, which could be beneficial in resisting disease. In contrast, high caeruloplasmin levels have been speculated to be a risk factor for atherosclerosis, based on its pro-oxidant properties.[8]

2. MATERIAL AND METHODS

Nine (9) different species of medicinal plants from different localities in Bosnia and Herzegovina are analyzed: *Mellisa officinalis*, *Salvia officinalis*, *Rosa canina*, *Sambucus nigra*, *Crataegus monogyna*, *Hypericum perforatum*, *Tilia cordata*, *Teucrium montanum* and *Calendula officinalis*. Determination of copper and zinc in samples of medicinal plants was carried out by atomic absorption spectrophotometry (AAS) on the instrument of Perkin-Elmer 3110, and in the extracts (1%) by optical emission spectrometry inductively coupled plasma (ICP-OES). The measure is done using the instrument ICP OPTIMA 2100 DV, Perkin-Elmer, Optical Emission Spectrometer. The antioxidant activity of the extracts was determined using FRAP method.

3. RESULTS AND DISCUSSION

Zinc and copper deficiencies, in absolute or relative terms, may be major contributors to certain symptoms and diseases. Some of these symptoms and diseases are closely related to aging and tend to occur at higher incidence rates in the elderly population, for example, impaired immunocompetency, wound healing, blunted taste acuity, bone abnormalities and cardiovascular disease.[9,10] Routine supplementation with zinc or copper may be ill advised given their interaction with each other and with other dietary components.[11] High doses of zinc hinder copper absorption by stimulating the synthesis of metallothionein, which has a high affinity for copper, within intestinal cells. Binding of copper by metallothionein reduces its mobility from the intestine into the bloodstream and increases its excretion as a result of cell sloughing.[12] In a few studies, a low copper intake in relation to zinc, as reflected by high Zn/Cu ratios, was implicated in the development of coronary heart disease. Zn/Cu ratios > 16 have been associated with increased risk of cardiac abnormalities. Food which is determined Zn/Cu > 16 is: beef, ground beef, pork, hot dogs/sausages, eggs and cheese.[13] Table 1. shows results of copper and zinc concentration in dry matter of medicinal plants and their extract. The content of copper and zinc in dry matter of the examined samples of medicinal plants varied in dependence of the type of a plant and locality, i.e., of an edaphic and orographic factors.[14] Values of copper and zinc in the dry matter of medicinal plants and extracts were within tolerable limits.

Table 1. Concentrations Cu and Zn in dry matter and extract of medicinal plants

| Plant | Zn [mg/kg] | Cu [mg/kg] | Zn [mg/L] | Cu [mg/L] |
|------------------------------|---------------|---------------|--------------|--------------|
| <i>Mellisa officinalis</i> | 32,3 | 8,4 | 1,87 | 0,57 |
| <i>Salvia officinalis</i> | 38,0 | 10,6 | 2,47 | 0,64 |
| <i>Rosa canina</i> | 17,0 | 4,2 | 3,22 | 0,47 |
| <i>Sambucus nigra</i> | 32,7 | 4,3 | 2,31 | 0,68 |
| <i>Crataegus monogyna</i> | 35,8 | 8,7 | 3,30 | 0,64 |
| <i>Hypericum perforatum</i> | 50,9 | 12,2 | 3,47 | 0,64 |
| <i>Tilia cordata</i> | 55,6 | 8,7 | 2,38 | 0,41 |
| <i>Teucrium montanum</i> | 64,8 | 12,0 | 2,59 | 0,39 |
| <i>Calendula officinalis</i> | 29,0 | 11,3 | 6,00 | 0,89 |

The greatest value of antioxidant activity was measured in extracts of plants *Mellisa officinalis*. Values of the Zn/Cu ratio in dry matter ranged from 3.58 to 7.60, and in the extracts of medicinal plants from 3.28 to 6.74. The data obtained have shown that the tested herbs had a favorable balance of these essential trace elements (Table 2.).

Table 2. Antioxidant activity and Zn/Cu ratio in dry mater and extract of medicinal plants

| Herbal extract | Antioxidant activity [$\mu\text{mol Fe}^{\text{II}}/\text{L}$] | Zn/Cu (dry mater) | Zn/Cu (extract) |
|------------------------------|--|-------------------|-----------------|
| <i>Mellisa officinalis</i> | 21070,00 | 3,84 | 3,28 |
| <i>Salvia officinalis</i> | 17520,00 | 3,58 | 3,85 |
| <i>Rosa canina</i> | 16783,60 | 4,04 | 4,73 |
| <i>Sambucus nigra</i> | 14733,60 | 7,60 | 4,91 |
| <i>Crataegus monogyna</i> | 14124,50 | 4,11 | 5,15 |
| <i>Hypericum perforatum</i> | 13679,00 | 4,17 | 5,42 |
| <i>Tilia cordata</i> | 4629,00 | 6,39 | 5,80 |
| <i>Teucrium montanum</i> | 3960,90 | 5,4 | 6,64 |
| <i>Calendula officinalis</i> | 2097,30 | 5,33 | 6,74 |

A negative correlation was obtained by comparing the values of antioxidant activity and relationships Zn/Cu in extracts ($r = 0,940$) (Figure 1.).

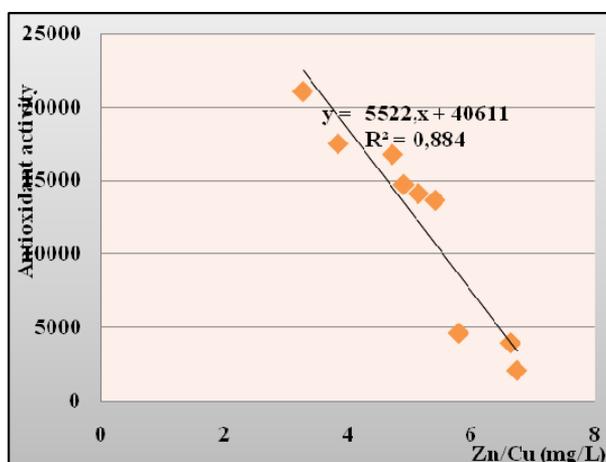


Figure 1. Corelation between Zn/Cu ratio and antioxidant activity inthe medical plant extracts

It is possible that a high ratio of Zn/Cu affects the synthesis of antioxidant components in the plant, resulting in a decrease in antioxidant activity. A high ratio of Zn/Cu in food has an impact on the bioavailability of these essential biominerals. Copper and zinc are antagonists during absorption because they bind to the same protein in the intestinal epithelium. In the case of the high content of zinc compared to copper in foods ($\text{Zn/Cu} > 16$) leads to insufficient absorption of copper, which can result in a disruption of the oxidant/antioxidant balance of the human body. The results show a negative correlation between the ratio of Zn/Cu and antioxidant activity in the samples. However, it is necessary to carry out extensive studies on a larger number of samples to obtain relevant information.

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