

*Original Research*

# Evaluation of Heavy Metals Contents in Spices and Herbs Available on the Polish Market

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## Abstract

Herbs and spices are sources of many bioactive compounds that can improve the taste of foods as well as influence digestion and metabolism processes. They can also contain some undesirable components that can be harmful, e.g. micotoxins, pesticides, heavy metals, and polycyclic carbohydrates residues.

The objective of this study was to determine Pb, Cd, Zn, and Cu contents in the most popular spices and herbs used in Polish cuisine. The content of these metals was assayed by the AAS method. The results were compared with the safety standards established by the National Ministry of Health. Excessive amounts of Pb were found in 40% of basil, 42% of cinnamon, 25% of savory and 6% of dried onion samples. Increased levels of Cd were detected in 20% of basil, 25% of savory and 42% of cinnamon samples. Zn and Cu levels in all herbs and spices were within the safe limits.

**Keywords:** spices, herbs, heavy metals

## Introduction

Herbs and spices grown in various regions of the world have been used for several purposes since ancient times. Several uses of these plants are for culinary purposes [1-4]. Spices and herbs belong to condiments, substances which do not contain nutritive components. Although a few dozen different spice plants are of global importance, many more are used as condiments locally, in the regions of their natural occurrence. Some of these are traded in small quantities and used in ethnic restaurants.

Spices have been recognized to have some medical properties due to antioxidant and antimicrobial action [5-7]. Many spices have been documented to possess anti-diabetic, antiinflammatory, and antihypertensive potential [8, 9].

Only a small fraction of the many biochemicals found in plants are relevant for the quality of spiciness; many classes are hardly ever found in spices, as their taste is unpleasant or they are not safe at all [10]. Even though spices have many benefits, they can also contain some toxic chemicals derived from the environment of their production, processing and storage conditions.

The aim of this study was to determine the safety of the most popular species of herbs used in Polish cuisine, as determined by heavy metals (Pb, Cd, Zn and Cu) residue.

## Material and Methods

The experimental material consisted of 13 groups: basil, savory, cinnamon, nutmeg, cinnamon, cloves, ginger, curcuma, black pepper, hot and sweet paprika, all-spice, dried garlic and onion. Samples were purchased

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directly from local markets in the Wielkopolska Region by workers of the Sanitary Epidemiological Station in Kalisz.

The content of metals was determined according to the procedure advised by the National Institute of Hygiene [11]. Samples were weighed (10-50 g) in quartz crucibles, dried at 105°C for 24 hours and subsequently ashed in the muffle furnace at 400°C. Ash was dissolved in 1mol/l nitric acid (GR, ISO, Merck) and filled up in 50 ml volumetric flasks to the mark by the same acid. The content of Pb and Cd in the mineralized sample was determined after extraction of the complexes with APDC (1-pyrrolidindithiocarbamate ammonium) to MIBK (methyl-*iso*-butylketon) phase (GR, ISO, Merck) by the

flame atomic absorption spectrometry (F-AAS) method. The content of Zn and Cu in the diluted sample solutions was determined by the same method (spectrometer AAS-3, Zeiss with BC). All the instrumental conditions applied for metal determinations were set in accordance with general recommendations (wave length for Pb, Cd, Zn and Cu: 283.3 nm, 228.8 nm, 213.9 nm and 324.8 nm, respectively) [11].

The accuracy and precision of the method was assured by simultaneous analysis of the reference material (lyophilized vegetable sample) provided by the National Institute of Hygiene in Warsaw, Poland. The laboratory obtained acceptable recovery for the analyzed metals (z-score values in accepted limits). The results were ex-

Table 1. Content of Pb, Cd, Cu and Zn in spices and herbs.

Name	n	MPL (mg/kg)	Pb	Cd	Cu	Zn
			1.0	0.1	20.0	50.0
Basil <i>Ocimum basilicum</i>	5	Mean Range n >MPL	0.55 0.07-1.20 2	0.07 0.03-0.11 1	9.12 2.38-12.70 0	20.07 8.20-38.70 0
Savory <i>Satureja hortensis</i>	4	Mean Range n >MPL	0.79 0.26-1.20 1	0.07 0.02-0.15 1	7.43 2.14-11.03 0	30.84 7.88-48.77 0
Cinnamon <i>Cinnamomum zeylanicum</i>	12	Mean Range n >MPL	1.49 0.17-5.43 5	0.14 0.02-0.30 5	5.11 2.31-8.00 0	17.88 5.68-38.00 0
Nutmeg <i>Myristica fragans</i>	8	Mean Range n >MPL	0.36 0.14-0.76 0	0.05 0.02-0.07 0	7.28 2.87-13.50 0	9.90 4.58-23.75 0
Cloves <i>Syzygium aromaticum</i>	3	Mean Range n >MPL	0.25 0.24-0.27 0	0.01 0.01-0.02 0	4.20 2.80-4.90 0	6.86 5.45-7.56 0
Ginger <i>Zingiber officinale</i>	4	Mean Range n >MPL	0.39 0.21-0.78 0	0.03 0.02-0.04 0	4.33 2.35-8.32 0	10.73 5.96-16.95 0
Curcuma <i>Curcuma longa</i>	11	Mean Range n >MPL	0.38 0.16-0.59 0	0.04 0.02-0.08 0	4.48 0.66-8.01 0	21.17 7.48-36.00 0
Sweet paprika <i>Capiscum annum</i>	5	Mean Range n >MPL	0.31 0.21-0.65 0	0.05 0.02-0.09 0	7.07 3.54-9.10 0	14.20 10.78-17.49 0
Hot paprika <i>Capiscum frutescens</i>	17	Mean Range n >MPL	0.39 0.09-0.72 0	0.05 0.02-0.10 0	7.94 1.42-23.52 1	13.09 6.29-18.27 0
Black grainy pepper <i>Piper nigrum</i>	18	Mean Range n >MPL	0.32 0.17-0.82 0	0.04 0.01-0.07 0	5.44 0.38-11.61 0	7.15 2.76-13.85 0
Garlic, dried <i>Allium sativum</i>	16	Mean Range n >MPL	0.53 0.14-1.03 1	0.04 0.01-0.08 0	5.25 2.23-10.76 0	18.90 6.43-33.44 0
Onion, dried <i>Allium cepa</i>	9	Mean Range n >MPL	0.44 0.34-0.61 0	0.05 0.01-0.07 0	5.03 1.65-12.71 0	13.87 5.84-31.00 0
Allspice <i>Pimenta dioica</i>	4	Mean Range n >MPL	0.29 0.25-0.33 0	0.03 0.02-0.03 0	5.30 4.50-6.00 0	11.26 10.00-12.00 0

MPL-maximum permissible limit (mg/kg); n-number of samples; n >MPL – number of samples exceeding MPL for a given metal

pressed in mg/kg of dry weight and evaluated by comparison with the Maximum Permissible Limits (MPL) on the basis of the National Food Standards [12]. Descriptive statistical parameters (mean, range) were calculated using the Excel Computer Programme (ver. 6).

## Results and Discussion

Herbs and spices belong to a group of condiments, therefore the levels of heavy metals were compared with the suitable safety standards as determined by the Maximum Permissible Limits (MPL) applied to "other foods and condiments" with dry weight content above 50%, established by the National Ministry of Health [12]. These values are as follows: Pb 1.0 mg/kg, Cd 0.1 mg/kg, Cu 20 mg/kg, Zn 50 mg/kg.

The mean and range values for the content of Pb, Cd, Zn and Cu in spices and herbs (expressed in mg/kg of dry weight (d.w.)), as well as the percentage of samples exceeding the MPL values are presented in Table 1.

Lead is the most recognized toxic environmental pollutant. It reacts or complexes with many biomolecules and adversely affects the reproductive, nervous, gastrointestinal, immune, renal, cardiovascular, skeletal and muscular systems as well as developmental processes [13]. As can be seen from Table 1, the average lead content varied from 0.25 mg/kg d.w. in cloves to 1.49 mg/kg d.w. in cinnamon, and exceeded the MPL for this metal in the latter spice. Besides, it was found that 2 out of 5 tested samples of basil, 5 out of 12 cinnamon samples, as well as 1 out of 4 samples of savory and 1 out of 16 samples of dry garlic contained excessive amounts of this toxic element.

Cadmium appears to mimic zinc, and to a lesser extent calcium and cadmium compounds are classified as human carcinogens [14]. Therefore, increasing this toxic element content in food is harmful. The average cadmium content ranged from 0.01 mg/kg d.w. in cloves to 0.14 mg/kg d.w. in cinnamon. Comparing the cadmium levels with the safety limits it was found that like in the case of lead, 5 out of 12 samples of cinnamon, 1 out of 4 samples of savory and 1 out of 5 samples of basil had increased amounts of this metal.

On one hand copper plays a role in the oxidative defense system, on the other hand chronic Cu toxicity can result in severe poisoning [15]. In this paper the average copper content was found to be low, ranging from 4.20 mg/kg d.w. in cloves to 9.12 mg/kg d.w. in basil. In only 1 out of 119 (6%) examined samples of hot paprika were established excessive amounts of this element found.

Zinc is a cofactor of over 200 enzymes involved in metabolic pathways but its high levels in human body can be toxic due to its interference with copper metabolism [16]. Therefore, dietary zinc intake should be appropriate. The content of zinc in the analyzed samples was relatively low and all of examined samples were found to contain an admissible quantity of this element. It has been confirmed that the average zinc content in spices and herbs ranged

from 6.86 mg/kg in cloves to 30.84 mg/kg in savory.

In the available literature data about the content of heavy metals in spices and herbs is scant. Bulinski and Błoniarz [17] investigated the Cd, Pb, Zn and Cr contents in plant spices. These authors found elevated amounts of Pb and Cd in cinnamon (6.24 mg/kg and 0.20 mg/kg, respectively), basil (2.25 mg/kg and 0.47 mg/kg, respectively) and savory (1.29 mg/kg and 0.40 mg/kg, respectively). Increased levels of Pb and Cd in those spices indicate that those plants presumably are prone to accumulate these elements from the environment. Chizzola et al. [18] suggest that Pb levels are generally higher in leaves than in other plant parts probably because Pb contaminations occur mainly through the atmosphere, whereas Pb uptake capacity of plants is generally low.

Abou-Arab and Abou Donia [19] and Sattar et al. [20] investigated the heavy metals content in spices and vegetables. They found excessive amounts of lead, cadmium and zinc in the examined mixed spices.

Abou-Arab and Abou Donia [19] and Murphy et al. [21] affirmed that the heavy metals contents in spices varied depending on the country of origin, environmental pollution levels, plant part and technological processes.

Generally in comparison with other references, in Germany and similarly in Austria, the reference values for leafy vegetables are fixed at 0.8 mg/kg Pb and 0.2 mg/kg Cd on a fresh weight basis [18]. In the European Union heavy metals in food are ruled by commission regulation (EC/466/2001), setting limits for lead (0.3 mg/kg) and cadmium (0.2 mg/kg) in leafy vegetables and fresh herbs [22]. On the other hand, the WHO recommendations are less restrictive. Maximum permissible limits in herbal medicines and products are 10 mg/kg and 0.3 mg/kg for Pb and Cd, respectively [23].

The results obtained in our study indicate that spices and herbs used for food and meals seasoning may contain relatively high levels of toxic metals (lead and cadmium), therefore, like other food products they should be under continuous monitoring.

## Conclusions

1. The content of toxic metals in plant spices and herbs was found to be generally low. However, nearly 8% and 6% of analyzed samples had elevated levels of lead and cadmium, respectively.
2. The highest contents of lead and cadmium was shown in cinnamon, basil and savory.
3. The contents of zinc and copper in spices and herbs was relatively low and met the appropriate safety standards.

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