Research Journal of Agriculture and Biological Sciences, 2(5): 223-226, 2006

Monitoring of Cadmium and Micronutrients in Spices Commonly Consumed in Turkey

[1]Faruk Ozkutlu, [2]Nazim Sekeroglu and [2]S. Metin Kara

[1]Department of Soil Science and Plant Nutrition,
Faculty of Agricultural, Ordu University, 52200, Ordu, Turkey.
[2]Department of Field Crops, Faculty of Agricultural, Ordu University, 52200, Ordu, Turkey.

Abstract: Interest in monitoring heavy metals and trace elements of spices and herbs has recently increased. Some tropical spices commonly consumed in Turkey were monitored as to their cadmium and some trace element contents such as Cu, Fe, Mn and Zn. Fifteen samples of allspice (*Pimenta dioica* (L.) Merrill), black pepper (*Piper nigrum* L.), cinnamon (*Cinnamomum zeylanicum* L.), nutmeg (*Myristica fragrans* Houtten), clove (*Szygium aromaticum* L. Merrill), galangal (*Alpina officinarum* Hance), cardamom (*Elettaria cardamomum* (L.) Maton), ginger (*Zingiber officinale* Roscoe) and turmeric (*Curcuma longa* L.) were analyzed. The results showed that cadmium and trace element contents of nine spices evaluated were within the low range. Cd was not detected in any samples of nutmeg. The level of Cd in the rest of the samples ranged from 13 mg kg^{-1} in clove to 206 mg kg^{-1} in black pepper. Content of Fe varied between 28 mg kg^{-1} in nutmeg to 374 mg kg^{-1} in black pepper. The level of Cu in the samples was within the range of 3.0-11 mg kg^{-1}. The highest Mn content was that of clove sample (355 mg kg^{-1}) whereas the lowest level was recorded in turmeric (10 mg kg^{-1}). Zinc content of the plant samples ranged between 4 and 25 mg kg^{-1} with cardamom containing the highest.

Key words: Heavy metals, spice, trace elements

INTRODUCTION

Pollution of general environment has increasingly gathered a global interest since the beginning of this century. In this respect, contamination of agricultural soils with heavy metals has always been considered a critical challenge in scientific community. Heavy metals are generally present in agricultural soils at low levels. Due to their cumulative behavior and toxicity, however, they have a potential hazardous effect not only on crop plants but also on human health. Among the heavy metals cadmium, a non-essential toxic element, is of special concern because of its potential toxicity at low concentrations[1,2].

There are a number of factors contributing to heavy metal contamination of agricultural soils including fertilizers, pesticides, atmospheric deposition from town wastes, industrial emissions, and metal production[3-5]. When agricultural soils are contaminated with heavy metals, they may easily enter into human food chain through the plants. It is clearly documented that several factors may affect the behavior of heavy metals in soils, their availability to plants and transfer form plants to humans[6-9].

In the past few decades, there has been a significant increase in production and use of spices and herbs in most countries due to their wide range of usage such as spice, herbal tea and traditional medicine. Although spices and herbs represent too little amount of total food intake, considerable levels of heavy metals may occur in these plants when they are grown in contaminated soils. Monitoring of toxic heavy metals in herbs and spices has recently been reported in different parts of the world[10-13].

Turkey has a high diversity of plants used spice, herb, and traditional medicine[14]. Several herbs and spices are either produced on small farmlands or naturally grow in different regions. On the other hand, some tropical spices such as black pepper, cinnamon, ginger, and turmeric are imported in significant quantities from the Fareast[15]. There is little information available about the safety of those plants and their products in respect to heavy metal contamination. The objective of this study was to establish the levels of cadmium and micronutrients of some selected tropical spices commonly consumed in Turkey.

MATERIALS AND METHODS

Sample collection and processing: Fifteen samples of nine species were obtained from spice wholesalers and

Corresponding Author: Faruk Ozkutlu, Department of Soil Science and Plant Nutrition, Faculty of Agricultural, Ordu University, 52200, Ordu, Turkey. Tel: +904522347098 Fax: +904522344000
E-mail: farukozkutlu@hotmail.com, fozkutlu@ktu.edu.tr

Table 1: Some characteristics of 9 selected spices

Plant scientific names	Common name	Turkish name	Parts used
Alpina officinarum Hance	Galangal	Havlıcan	Rhizome
Cinnamomum zeylanicum L.	Cinnamon	Tarçın	Bark
Curcuma longae	Turmeric	Zerdeçal	Rhizome
Elettaria cardamomum (L.) Maton	Cardamom	Kakule, Hel	Seed
Myristica fragrans Houtten	Nutmeg	Küçük Hint Cevizi	Seed
Pimenta dioica (L.) Merrill.	Allspice	Yenibahar	Seed
Piper nigrum L.	Black pepper	Karabiber	Seed
Szygium aromaticum L. Merr.	Clove	Karanfil	Bud
Zingiber officinale Roscoe	Ginger	Zencefil	Rhizome

local spice shops in southeastern Turkey (Adana, Mersin, Kilis, Gaziantep and Hatay provinces) in October 2005. Table 1 shows the plant names and the part of the plant used. The samples (100 g) in the plastic bags were kept at room temperature until to be analyzed. The samples were dried at 70 °C for 48 hours in an oven and ground for chemical analysis.

Analysis: In summary, 0.2 g of the sample was transferred into a burning cup and 5 ml of 65% HNO_3 and 2 ml of 30% H_2O_2 were added. The samples were incinerated in a microwave at 200 °C and cooled at room temperature for 45 minutes. The filtrated extracts were collected by high-deionized water in a 20 ml-polyethylene bottles and kept at 4 °C in laboratory for ICP-AES analysis. Each sample was analyzed in triplicate. Merck standards (R1 and R2 groups) were used as analytical reagent grade chemicals. Standard solutions of Cd, Cu, Fe, Mn and Zn were prepared in 1 % HNO_3 immediately before the analysis by serial dilution of 1000 mg L^{-1} stock solution. Peach Leaves (Standard Reference Material, 1547) and Corn Bran (Standard Reference Material, 8433) were used as reference materials[16]. The ICP-AES was used to determine Cu, Fe, Mn, and Zn in the extracts. For determining Cd concentration ICAP-OES was also used. Analytical recovery of the method has been checked by a parallel analysis of the two certified reference materials.

RESULTS AND DISCUSSIONS

Cadmium and trace metal contents in the samples studied are presented in Table 2. Cd content of nine spices differed in a wide range. In any sample of nutmeg, Cd couldn't be detected. The highest mean level of Cd (206 µg kg^{-1}) was found in black pepper samples. On the other hand, the lowest mean level of Cd was recorded in clove samples (13 µg kg^{-1}). The samples of cardamom and cinnamon were relatively richer in Cd concentration.

Copper concentrations of the plant samples ranged between 3 to 11 mg kg^{-1} with the highest values were in nutmeg and black pepper. Iron content of the samples was relatively high in only three cases and ranged from 374 (black pepper) to 28 (nutmeg) mg kg^{-1}. Manganese content of nine spices was in a wide range. The clove samples were found as the richest (355 mg kg^{-1}) in Mn content followed by galangal (327 mg kg^{-1}) while the lowest Mn levels were obtained in turmeric (10 mg kg^{-1}) and allspice (11 mg kg^{-1}), respectively. Zinc concentrations of the plant samples ranged between 4 and 25 mg kg^{-1} with cardamom sample containing the highest and turmeric having the lowest, respectively.

The results of the present study indicated that cadmium and trace metal contents of some selected spices were within the low range. Although there was no clear tendency in the content of Cd and micronutrients of spices evaluated, black pepper, cardamom, and cinnamon appeared to be relatively rich in both Cd and Mn.

The reported levels for Cd, Cu, Fe, Mn, and Zn in the present study were noticeable lower than the ones previously found in herbs and spice plants in different parts of the world. The highest cadmium concentration found in the present work was in black pepper (206 µg kg^{-1}) followed by cardamom (151 µg kg^{-1}), and cinnamon (124 µg kg^{-1}), which are much lower than the limit of 300 µg kg^{-1} recommended for herbs and spice plants[17]. As indicated in Table 2, from all the determined trace elements the highest content was found that of iron, 374 mg kg^{-1} in the seed of black pepper followed by that of manganese, 355 mg kg^{-1} in the bud of clove.

Cadmium concentrations of medicinal plants studied in Italy, Egypt and Brazil were found in a wide range of 10-750 µg kg^{-1}, 50-300 µg kg^{-1}, and <0.2 to 0.74 µg g^{-1} respectively[11, 13, 18]. On the other hand, Chizzola *et al*.[12]

Table 2: Cadmium and micronutrient concentrations of selected medicinal plants (n = 15 ± SD, dry weight)

Plantsample	Cd (µg kg^{-1})	Cu (mg kg^{-1})	Fe (mg kg^{-1})	Mn (mg kg^{-1})	Zn (mg kg^{-1})
Alpina officinarum Hance	76±3,1	3±0,8	266±5,2	327±4,4	11±0,5
Cinnamomum zeylanicum L.	124±0,9	4±1,7	67±4,3	107±0,5	10±1,0
Curcuma longa L.	29±2,1	3±1,1	98±0,5	10±0,4	4±0,4
Elettaria cardamomum (L.) Maton	151±5,2	5±0,7	73±2,2	168±2,5	25±0,8
Myristica fragrans Houtten	*	011±0,9	28±6,4	15±0,8	10±0,4
Pimenta dioica (L.) Merrill.	15±0,7	5±0,5	128±2,9	11±0,8	5±0,4
Piper nigrum L.	206±6,7	11±0,5	374±7,0	191±1,5	11±0,6
Szygium aromaticum L. Merr.	13±1,7	4±1,0	52±4,6	355±0,7	6±0,5
Zingiber officinale Roscoe	72±4,1	3±0,8	34±1,1	73±3,4	5±0,9

*: Could not be detected

reported that contents of heavy metals and metallic micronutrient were generally within the usual range in herbs, spices and medicinal plants from Austria. They concluded that contamination levels with Cd and Pb could be classified as normally low. Micronutrient concentrations were generally higher in leaves than in other aboveground plant parts. In a study form Turkey, cadmium content ranged from 1.2 to 440 µg kg^{-1} in some herbal teas[19]. The mean levels of Fe, Cu, Mn, and Zn were in intervals of 228-810 mg kg^{-1}, 3.92-35.8 mg kg^{-1}, 23-244 mg kg^{-1} and 21.9-47.2 mg kg^{-1}, respectively.

The result of this study revealed that the values reported here, particularly for cadmium, are far below the recommended levels. Therefore, content of cadmium and other trace metals of some selected tropical spices commonly consumed in Turkey may not be considered a critical issue. However, it is useful to monitor heavy metals in widely used spices to be aware of a potential risk in future.

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