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Research Article

DETERMINATION OF MINERAL AND TRACE ELEMENT IN SOME MEDICINAL PLANTS BY SPECTROSCOPIC METHOD

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ABSTRACT

In this paper, the concentrations of elemental contents ((Macro mineral; calcium (Ca) and magnesium (Mg), trace elements; zinc (Zn), copper (Cu) and iron (Fe) and ultra-trace elements aluminum (Al), manganese (Mn), lead (Pb) and nickel (Ni) in some medicinal plants like dill (*Anethum graveolens L*.), clove (*Syzygium aromaticum*), cardamom (*Elettaria cardamomum*), black mulberry (*Morus nigra*), oak gall (*Quercus infectoria*), camomile (*Matricaria recutita L*), basil (*Ocimum basilicum*), peppermint (*Mentha x piperita*), ginger (*Zingiber officinale*), purslane (*Portulaca Oleracea L*.), thyme (*Thymus vulgaris L*.) and cinnamon (*Cinnamomum verum*)) were determined with High Resolution Continuum Source Flame Atomic Absorption Spectrometer (HR CS-FAAS) by using the microwave digestion system. We found metal levels in investigating medicinal plants in the ranges: 0.18- 5.63 mg/g for Ca; 0.06- 1.37 mg/g for Mg; 0.01–0.03 mg/g for Al; 2.84 - 79.48 µg/g for Zn; 2.77–74.38 µg/g for Fe; 0.41 113.01 µg/g for Pb; 0.13–0.54 µg/g for Ni; 0.04 50.51 µg/g for Mn and 0.01–5.97 µg/g for Cu. The highest concentrations of the examined elements in the plants examined were found as follows: Ca in basil; Mg in purslane; Pb, Al and Zn in dill; Fe and Mg in ginger. Likewise, the lowest concentrations were found as follows: Pb in thyme; Zn in black mulberry; Cu in clove and Ni in cinnamon.

Keywords: Medicinal plant; microwave digestion; mineral; trace elements.

1. INTRODUCTION

Medicinal herbs can synthesize a variety of chemical compounds that are used to carry out important biological vital functions [1]. The use about therapeutic plants need been a vital part from human health care in many cultures for centuries. It was found in Iraq on the first cultural significance plant waste record of about 60.000 a year ago in 1960 at the Neanderthal human burial site [2]. Medicinal herbs have a promising future because there are about half a million herbs worldwide, and many of them have not investigate yet their medical activities, and their medical activities could be decisive in the treatment of current or future studies [3].

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Trace elements bear a unique name and various definitions the mode of its study can determine which can also describe them, also we know them as likely toxic elements, heavy metals, trace metals, minor elements, and micronutrients. The term “toxic elements’’ is a recent word used to explain that some of these elements are toxic to both plant and animals, and just a few are poisonous in a certain amount of concentrations [4]. The IUPAC Gold Book defines trace elements as “Any element having an average concentration of less than about 100 parts per million atoms” [5]. Soil fertility experts define trace elements as minerals that are "toxic" to herbs at the highest concentration level, but are essential for medicinal plant growth in negligible quantities. Toxicologists consider minerals those trace elements distributed into the environment by industrial processes harmful to the environment or human health [6].

We may categorize trace elements including heavy metals into two classes depending on whether the biological processes keep them at the correct level in our bodies. We call them essential or non-essential based on their biological effects, diseases that occur because of their deficiency and toxicity because of overdose. Copper (Cu), selenium (Se), iron (Fe), chromium (Cr), manganese (Mn), zinc (Zn), cobalt (Co), fluorine (F), iodine (I) and molybdenum (Mo) are called essential trace elements. The border line or probably essential are nickel (Ni), titanium (Ti), vanadium (V), silicon (Si) and boron (B). Elements such as aluminum (Al), arsenic (As), barium (Ba), bismuth (Bi), bromine (Br), cadmium (Cd), gold (Au), lead (Pb), lithium (Li), mercury (Hg), rubidium (Rb), silver (Ag), strontium (Sr), Ti and zirconium (Zr) are called non-essential. An element is considered essential when its reduction below the required concentration affects the physiological state of an organism’s body. Non-essential elements show adverse health effects to organisms irrespective of their concentration level [7-9].

The aim of the present study was to investigate the elemental contents of naturally grown some medicinal plants dill (*Anethum graveolens L.*), clove (*Syzygium aromaticum*), cardamom (*Elettaria cardamomum*), black mulberry (*Morus nigra*), oak gall (*Quercus infectoria*), camomile (*Matricaria recutita L*), basil (*Ocimum basilicum*), peppermint (*Mentha x piperita*), ginger (*Zingiber officinale*), purslane (*Portulaca Oleracea L.*), thyme (*Thymus vulgaris L.*) and cinnamon (*Cinnamomum verum*)) in Northern region of Iraq The samples were determined with High Resolution Continuum Source Flame Atomic Absorption Spectrometer (HR CS-FAAS) by using the microwave digestion system.

2. EXPERIMENTAL

2.1. Sample Collection

Parts of the 13 medicinal plants dill (*Anethum graveolens L.*), clove (*Syzygium aromaticum*), cardamom (*Elettaria cardamomum*), black mulberry (*Morus nigra*), oak gall (*Quercus infectoria*), camomile (*Matricaria recutita L*), basil (*Ocimum basilicum*), peppermint (*Mentha x piperita*), ginger (*Zingiber officinale*), purslane (*Portulaca Oleracea L.*), thyme (*Thymus vulgaris L.*) and cinnamon (*Cinnamomum verum*))and cinnamon (*Cinnamomum verum*)) selected for the study such as stem barks, seeds, root barks, inner bark, flowers and leaves, were collected from a local market in Erbil in northern Iraq in 2016. The collected samples were washed, dried in the shade (32°C - 40°C), powdered and prepared for analysis. Powdered plant materials were kept at room temperature away from direct sunlight [10].

2.2. Reagents and Standards

All solutions were prepared using ultra-pure water (specific resistance 18 MΩ cm) from a Milli-Q purification system (Millipore Corporation, Massachusetts, USA). Standard solutions of analyte were prepared from their 1000 mg L^{-1} stock solutions (Merck). All glassware was cleaned using ultra-pure water, kept in nitric acid for 24 h, and washed again with ultra-pure water.

2.3. Instrumentation

The analysis was performe d by ContrAA 300 a High Resolution-Continuum Source Flame Atomic Absorption Spectrometer (HR-CS AAS) (Germany, Berlin, GLE) equipped with a 50 mm burner head. All absorption lines of an element in the spectral range of 185-900 nm can be analytically evaluated using a Xe short-arc lamp as a continuum lamp source. The spectral background of the sample in the HR-CS FAAS is always corrected directly on the analysis line simultaneously and independently. All measurements were carried out under optimum conditions in three replicates.

Table 1. Characteristics data of the calibration curves of elements using (HR-CS FAAS)

Metal	Calibration equation (mg/ L)	Correlation coefficient (R^2)	Dynamic range (mg/ L)	Wave length (nm)
Cu	y = 0.1187x + 0.0042	0.9999	0.2- 2	324.754
Pb	y = 0.0294x + 0.0049	0.9971	0.2-10	217.001
Zn	y = 0.1782x + 0.1166	0.9916	0.2- 1	213.856
Al	y = 0.0100x + 0.0007	0.9979	0.2- 10	396.152
Mn	y = 0.1826x + 0.0175	0.9999	0.2- 1	257.611
Ni	y = 0.0804x + 0.0008	0.9999	0.2- 2	231.604
Fe	y = 0.0614x + 0.0084	0.9974	0.2 – 20	259.941
Ca	y = 0.2128x – 0.0013	0.9999	0.2 – 5	422.673
Mg	y = 0.3922x + 0.1635	0.9972	0.2 – 2	279.079

2.4. Sample Preparation

The medicinal plants samples were digested in the microwave. A 0.20 g portion of each plant sample was transferred into PTFE (polytetrafluoroethylene) bombs and acid mixture (5/1) of concentrated HNO_3 (65%(w/w)) and $HClO_4$ (70-72%(w/w)) were added to samples. The mixtures were kept standing overnight at room temperature for pre-digestion. Then, the PTFE-bombs with the mixtures were tightly closed and put in a microwave oven. In a tightly closed system, the five-step microwave digestion program (200 W, 5 min; 0 W, 5 min; 400 W, 5 min; 0 W, 5 min and 800 W, 5 min) was applied [11]. PTFE bomb was kept for an hour to cool and was carefully opened. Subsequently, the dissolved program was applied until a clear solution was obtained. Colorless solution was transferred into a beaker and evaporated to dryness with a hot plate Afterwards final volume was diluted to 10 mL with 1% HNO_3 solutions. The clear solutions were analyzed by HR-CS FAAS for the determination of minerals and trace elements. In addition, blank samples were prepared and analyzed using same method. Results of medicinal plants for analysis were given in Table 2 and Table 3.

3. RESULTS AND DISCUSSION

Thirteen medicinal plants were determined by HR-CS AAS, the different concentrations of elements in the thirteen medical herbs are shown in Table 2 and Table 3 [12]. The trace elements and minerals in medicinal plants get into the plant or herb by absorption from soils or nutrient solutions through roots, foliar or translocation [13]. The variation in elemental concentration is mainly attributed to the differences in botanical structure, as well as in the mineral composition of the soil in which the plants are cultivated. Other factors responsible for a variation in elemental content are preferential absorbability of the plant use of fertilizers, irrigation water and climatological conditions [14]. In this study, Thirteen medicinal plants were determined by HR-CS FAAS, the different concentrations of elements in the thirteen medicinal plants are shown in

Table 2 and Table 3. The distribution levels of the trace elements examined in this study are given in Figure 1.

Table 2. Concentrations (μg/g) of elements in medicinal plants, samples analyzed by (HR CS-FAAS)

Name of the herbs	Cu (μg/g)	Zn (μg/g)	Fe (μg/g)	Pb (μg/g)	Mn (μg/g)	Ni (μg/g)
Dill	1.76±0.09	79.48±3.65	49.76±2.82	113.01±4.55	0.39±0.04	0.52±0.05
Clove	0.01±0.001	3.41±0.03	18.80±3.78	4.39±0.38	32.12±2.30	0.30±0.02
Cardamom	0.28±0.05	5.75±0.45	2.81±0.24	4.23±0.36	16.30±2.15	0.54±0.09
Black mulberry	0.49±0.03	2.84±0.26	9.65±0.97	2.63±0.02	1.89±0.17	0.32±0.02
Oak Galls	5.97±0.56	12.92±1.18	2.77±0.21	2.31±0.22	0.04±0.01	0.29±0.02
Chamomile	1.41±0.12	8.39±0.75	13.61±1.12	3.22±0.31	6.90±0.53	0.35±0.03
Basil	2.30±0.21	8.84±0.78	31.81±3.52	3.01±0.22	7.57±0.64	0.48±0.04
Peppermint	0.81±0.07	5.84±0.42	27.65±2.45	1.12±0.10	8.15±0.73	0.37±0.02
Ginger	0.20±0.01	5.47±0.52	74.38±5.33	0.87±0.07	50.51±4.25	0.32±0.03
Purslane	0.18±0.01	4.62±0.33	42.85±2.92	1.08±0.12	12.72±1.91	0.52±0.04
Coriander	0.96±0.08	5.43±0.51	4.66±0.42	1.00±0.09	3.13±0.32	0.21±0.15
Thyme	0.61±0.05	5.44±0.52	57.57±3.83	0.41±0.03	6.33±0.55	0.34±0.28
Cinnamon	0.38±0.03	3.33±0.32	6.01±0.45	0.61±0.05	37.22±3.12	0.13±0.01

Table 3. Concentrations (mg/g) of elements in medicinal plants, samples analyzed by (HR CS-FAAS)

Name of the herbs	Mg (mg/g)	Ca (mg/g)	Al (mg/g)
Dill	0.98±0.08	4.09±0.45	0.03±0.01
Clove	0.63±0.05	1.23±0.11	0.01±0.001
Cardamom	0.55±0.04	0.94±0.08	0.01±0.002
Black mulberry	0.27±0.01	1.38±0.12	0.01±0.01
Oak Galls	0.06±0.01	0.18±0.01	0.01±0.001
Chamomile	0.35±0.03	1.85±0.16	0.01±0.005
Basil	0.94±0.01	5.63±0.36	0.02±0.001
Peppermint	0.48±0.03	2.33±0.21	0.01±0.001
Ginger	0.35±0.02	0.31±0.03	0.03±0.01
Purslane	1.37±0.12	3.64±0.31	0.02±0.01
Coriander	0.36±0.03	0.69±0.06	0.01±0.001
Thyme	0.64±0.05	4.14±0.37	0.03±0.01
Cinnamon	0.28±0.02	1.64±0.13	0.01±0.002

Table 4 shows a comparison of results concentrations of elements in literature published reports of medicinal plants.

3.1. Calcium

The concentrations of Ca in samples studied ranged from 0.18 to 5.63 mg/g. Among all samples, the highest Ca concentration was determined in basil (5.63 mg / g) and the lowest calcium (Ca) concentration was determined in oak galls (0.18 mg / g). The plants of purslane, dill, thyme, basil are rich in Ca (3.64, 4.09, 4.14 and 5.63 mg/g) respectively and are recommended for use in Ayurvedic medicine in calcium deficient cases. Ca concentrations in the studied samples were found as 4.14, 1.64, 2.33 and 1.85 mg / g for thyme, cinnamon, mint, and chamomile, respectively (Table 3). These values in Turkey; it was found as 13.81, 9.60 and 11.94 mg / g for cinnamon, mint and thyme, respectively (Table 4). Compared with all medical plant, the higher Ca concentration thyme grown in Turkey in 13.81 mg / g is found as the lowest concentration of 0.189 mg/g Chamomile Poland (Table 4) [15, 16]. Calcium is an essential nutrient that affects some processes involving enzymes, some metabolic reactions, blood coagulation, and skeleton rigidity. Likewise, calcium plays an important role in the transmission of hormonal effects to target organs through some intracellular signaling pathway. Calcium supplements are recommended because low calcium intake may cause preeclampsia in pregnant women [17].

3.2. Magnesium

The concentrations of Mg in samples studied ranged from 0.06 to 1.37 mg/g. Table 3 shows that the Mg concentration was 1.37 mg/g in the highest purslane (Portulaca oleracea L). We also found that the Mg concentration in oak galls (dyer's oak) (Quercus infectoria) was the lowest (0.06 mg/g). Purslane, dill, basil and thyme were found to be the richest sources of magnesium with concentrations of 1.37 mg/g, 0.98 mg/g, 0.94 mg/g and 0.64 mg/g, respectively. When the samples of cloves, cinnamon, cardamom, coriander and chamomile were studied, the Mg concentration was found to be 0.63, 0.28, 0.55, 0.36 and 0.35 mg/g, respectively, lower than purslane, dill, basil and thyme (Table 3). When these values are compared for cloves, cinnamon, cardamom and coriander (2.483, 0.4292, 3.87 and 2.67 mg/g) grown in Pakistan; Among these examined medicinal plants, the Mg concentration was found to be at the highest concentration with 3.87 mg / g in cardamom [18] and the lowest concentration with 0.218 mg/g in chamomile grown in Poland (Table 4) [16]. In addition to being used as a cofactor of many enzymes, magnesium is involved in protein synthesis, energy metabolism, DNA and RNA synthesis, and also in the protection of the electrical potential of nerve tissues and cell membranes. Additionally, low Mg may be associated with hypertension, cardiovascular problems, and diabetes [17].

3.3. Zinc

Table 2 shows the concentrations of Zn in all the medicinal plants samples studies ranged from 2.84 to 79.48 μg/g. Zn was determined at the lowest concentration in black mulberry with a value of 2.84 μg/g and the highest concentration in dill with a value of 79.48 μg/g. When studied on chamomile, cinnamon and mint samples, Zn concentrations were found as 8.39, 3.33 and 5.84 μg/ g, respectively (Table 2). When these values were compared for all samples examined, it was seen that chamomile and peppermint grown in Poland (88.8 and 75.3 μg/g) had the highest concentration [16] and the lowest concentration (0.216 μg/g) in cinnamon Iraq (Table 4) [19]. Zn balances the molecular structure of cellular components and cell membranes and contributes to the preservation of cell integrity. It is an essential component of many enzymes involved in the synthesis and breakdown of carbohydrates, proteins, lipids and nucleic acids. In addition, Zn plays an important role in the immune system and polynucleotide transcription, as well as for insulin [17].

3.4. Iron

The concentrations of Fe in samples studied ranged from 2.77 to 74.38 μg/g. In the various medicinal plant samples analyzed, the Fe content; The maximum (74.38 μg/g) in ginger and minimum (2.77 μg/g) values in oak galls are shown in Table 2. Therefore, it may be recommended to use ginger in the preparation to compensate for the Fe deficiency.

Fe concentration in the samples; worked on peppermint, cinnamon, basil, ginger, chamomile, dill for 27.65, 6.01, 31.81, 74.38, 13.61 and 49.76 μg/g, respectively (Table 2). These values, peppermint, cinnamon, basil, ginger, chamomile and dill (respectively 546, 108, 769, 345, 716 and 220 mg/g) as compared to, basil grown in Turkey the highest concentration of Fe content [20], lowest Fe content at a concentration (0.470 µg/g) was observed in cinnamon and basil grown in Iraq (Table 4) [19]. Fe has three basic functions in the human body: one; It is likely part of hemoglobin and responsible for oxygen transport. Another; It provides a healthy immune system and is responsible for energy production as a component of various enzymes. The other; it is an active site for several enzymes. Worldwide, Fe deficiency can be considered the most common nutritional deficiency [17].

3.5. Copper

The concentrations of Cu in samples studied ranged from 0.01 to 1.76 µg / g. For the samples analyzed, Table 2 shows that Cu in oak galls has the highest concentration (5.97 µg / g), but the Cu concentration in clove (0.01 µg / g) is the lowest in all studied medicinal plants compared to other trace elements. Cu concentrations in the samples were found to be 1.41, 0.38, 1.76, 2.30 and 0.96 µg / g for chamomile, cinnamon, dill, bacillus and coriander, respectively (Table 3). When these values are compared with chamomile, cinnamon, dill and basil grown in Iraq (0.140, 0.068, 0.051 and 0.077 µg / g respectively); It has been observed that Cu in dill grown in Iraq has the smallest concentration (0.051 µg / g) while Cu found in coriander grown in India has the highest concentration (74.41 µg / g) (Table 4) [21]. Cu has one of the most important roles in human health and is involved in erythropoietin, myelin formation, modulation of catecholamine metabolism and antioxidant protection, and regulation of immune functions, cholesterol and glucose metabolism. For medicinal plants, WHO has not yet set limits for copper [17].

3.6. Manganese

Table 2 shows Mn concentrations ranging from 0.04 to 50.51 µg / g. According to the table, the smallest concentration was found for oak galls (0.04 µg / g), while the highest concentration was found for ginger (50.51 µg / g). When the concentration of Mn was examined in the samples, 37.22, 3.13, 32.12 and 16.30, µg / g values were found for cinnamon, coriander, clove and cardamom, respectively (Table 2). When these values are compared with cinnamon, coriander, clove and cardamom (879.8, 48.74, 649.9 ve 758.1 µg / g) grown in Pakistan [22]; it has been found the highest concentration in cinnamon grown in Pakistan (879.8µg / g) and the lowest concentration (11.9 µg / g) in the coriander grown in Saudi Arabia (Table 4) [23]. Although Mn has a role in neurodegenerative diseases, it is essential for normal growth, development and cellular homeostasis. Mn may also be associated with therapeutic properties for cardiovascular diseases and diabetes [17].

3.7. Nickel

Table 2 shows the concentrations of Ni in all the medicinal plants samples studies ranged from 0.04 to 37.22 µg/g. Although Ni has important biochemical activities for humans and animals, these qualities have not yet been fully explained. Ni can be found as a cofactor or structural component for specific metalloenzymes in various organisms [24].

According to the analysis results, Table 2 shows that cardamom has the highest Ni concentration (0.54 µg / g) and cinnamon has the lowest concentration (0.13 µg / g). According to Table 2, dill and purslane have similar Ni concentration (0.52 µg / g). In addition, ginger and black mulberry also have similar Ni concentrations (0.32 µg / g). Compared with samples grown in these values Turkey, dill grown in Turkey highest Ni concentration (7.59 mg / g) whereas the Dill growing in Iraq at low N concentration (0.023 mg / g) was found to have (Table 4) [19].

3.8. Lead

Table 2 shows that dill has a high concentration of Pb (113.01 µg / g) and thyme has the lowest concentration (0.41 µg / g) in terms of Pb content. The Pb level in the dill sample was found to be significantly higher compared to other studied samples and other plants in the literature. Lead is not an essential mineral for humans and is "very toxic" to the kidneys and nervous system. Also, Pb has no physiological or biochemical significance and is considered a "toxic" contaminant [25].

3.9. Aluminum

The concentrations of Al in samples studied ranged from 0.01 to 0.03 mg/g. Dill, ginger and thyme have similar Al values (0.03 µg / g). While this value has the highest Al concentration, clove, cardamom, oak galls, peppermint, chamomile, coriander, cinnamon and black mulberry have similar and lowest concentration values (0.01 µg / g). Purslane and bacillus have the same concentration content in Al (0.02 mg / g) (Table 3). Received on the daisy the Al concentration and the references cited studies in example concentrations compared (0.01 mg / g) (Table 3) daisy grown in Turkey concentration of 0.356 mg / g of the highest while having Al concentrations [26] grown daisy 0.122 mg/g in Poland It has the lowest concentration with the value of (Table 4). In this case, the Al concentration in the chamomile sample we examined is higher than these value [16].

Table 4. Investigation Compared of mineral concentrations (Cu, Zn, Fe, Pb, Mn, Ni, μg/g), and (Mg, Ca, Al, mg/g) of medicinal plants in different countries and the method of analysis in present study published reports in the literature

Name of the plants	Country	Samples analyze by	Reference	Cu (μg/g)	Zn (μg/g)	Fe (μg/g)	Pb (μg/g)	Mn (μg/g)	Ni (μg/g)	Mg (mg/g)	Ca (mg/g)	Al (mg/g)
Chamomile	Turkey	FAAS, ICP-AES.	[26]	8.34±0.05	30.6±2.1	502.7±3.0	0.72±0.08	60.2±3.3	1.8±0.4	1.64±0.07	12.72±0.2	0.356±0.023
Cinnamon	Turkey	ICP-OES, ICP-MS	[27]	3.3	17.9	56.7		104	0.6	0.852	10.978	
Thyme	Turkey	ICP-OES, ICP-MS	[27]	6.1	22.4	440		116	1.5	2.115	7.759	
Ginger	Turkey	ICP-OES, ICP-MS	[27]	4.0	13.5	86.8		127	1.9	2.006	0.944	
Chamomile	Turkey	ICP-OES, ICP-MS	[27]	8.2	24.4	521		96.4	1.5	2.319	6.959	
Peppermint	Turkey	ICP-OES, ICP-MS	[27]	17.7	17.9	975		112	1.0	2.929	11.749	
Cinnamon	Pakistan	ICP-MS	[22]	2.83± 0.01	13.75±0.06		0.1627± 0.00158	879.8± 0.55	0.94±0.01			
Coriander	Pakistan	ICP-MS	[22]	7.82± 0.04	37.85±0.02		0.2134± 0.00045	48.74±0.05	1.35±0.02			
Clove	Pakistan	ICP-MS	[22]	2.35± 0.03	14.00±0.01		0.3661±0.29	649.9±0.46	1.08±0.01			
Cardamom	Pakistan	ICP-MS	[22]	6.18± 0.04	61.18±0.03		0.4511± 0.00054	758.1± 0.54	1.99±0.02			
Thyme	Turkey	ICP-AES, ICP-MS	[15]	12.17±0.52	20.4 ± 1.7	301 ± 26		44.5 ± 1.6	2.34±0.09	1.67± 0.06	13.81±0.60	
Cinnamon	Turkey	ICP-AES, ICP-MS	[15]	2.78 ±0.20	38.3 ± 3.2	53 ± 4.9		156.2±12.6	0.32±0.05	0.40± 0.02	9.60 ± 0.53	
Peppermint	Turkey	ICP-AES, ICP-MS	[15]	10.04±0.79	23.6±2.2	281 ± 19		98.0 ± 0.9	2.40± 0.27	3.63± 0.02.57	11.94± 0	
Peppermint	Turkey	ICP-MS	[20]	11.1 ± 0.7	24.3 ± 1.4	546 ± 23	0.36± 0.03	140 ± 2	4.40± 0.00			

Cinnamon	Turkey	ICP-MS	[20]	4.68 ±0.29	13.0 ± 1.9	108 ± 7	0.31 ± 0.06	264 ± 31	0.72± 0.06			
Basil	Turkey	ICP-MS	[20]	30.2 ± 4.3	34.7 ± 2.8	769 ± 68	0.49 ± 0.02	102 ± 7	1.53±0.04			
Ginger	Turkey	ICP-MS	[20]	17.6 ± 2.7	26.6 ± 0.9	345 ± 18	3.01 ± 0.60	255 ± 9	2.26±0.12			
Chamomile	Turkey	ICP-MS	[20]	13.9 ± 0.5	22.2 ± 0.8	716 ± 65	0.06 ± 0.00	41.6 ± 3.0	3.68±0.04			
Dill	Turkey	ICP-MS	[20]	14.7 ± 0.5	22.8 ± 0.6	220 ± 1	0.46 ± 0.02	62.0 ± 0.9	7.59±0.43			
Coriander	Sudan	ICP-OES, ICP-MS	[28]	11.3 ± 0.2	39.3 ± 0.4	107 ± 10		22.8 ± 1.6		3.455±0.0073		
Clove	Pakistan	ICP-OES	[18]			623.2±9.5				2.483±0.02	6.778±0.038	
Cinnamon	Pakistan	ICP-OES	[18]			46.12±1.01				0.4292±0.00683	8.323±0.044	
Cardamom	Pakistan	ICP-OES	[18]			57.99±1.12				3.87±0.023	4.177±0.02	
Coriander	Pakistan	ICP-OES	[18]			71.31±1.04				2.67±0.003	6.577±0.034	
Clove	Saudi Arabia	AAS	[23]	3.2±0.1	6.3±0.9	90.4±6.0	0.7±0.01	490±14	1.8±0.1			
Cinnamon	Saudi Arabia	AAS	[23]	3.9±0.1	5.2±0.3	65.6±1.4	27±0.09	309±18	1.6±0.1			
Ginger	Saudi Arabia	AAS	[23]	2.5±0.3	7.9±0.7	231±41	0.8±0.06	97.9±9.7	1.0±0.03			
Coriander	Saudi Arabia	AAS	[23]	8.4±0.1	16.9±0.3	48.8±3.3	1.4±0.3	11.9±3.1	2.1±0.05			
Coriander	India	AAS	[21]	74.41±3.65	16.99±0.58	223.79±4.04	2.87±0.26	101.50±0.90		0.22235±0.0001 4		
Peppermint	Poland	ICP-OES	[16]	1.75±0.02	75.3±0.1	37.9±0.5		12.0±0.1		0.422±0.002	0.489±0.003	0.238±0.002
Chamomile	Poland	ICP-OES	[16]	1.38±0.01	88.8±0.5	15.7±0.2		13.8±0.1		0.218±0.001	0.189± 0.002	0.122±0.001
Chamomile	Iraq	FAAS	[19]	0.140	1.250	6.870	0.046		0.450			
Cinnamon	Iraq	FAAS	[19]	0.068	0.216	0.470	0.042		0.110			
Dill	Iraq	FAAS	[19]	0.051	0.990	1.280	0.110		0.023			
Basil	Iraq	FAAS	[19]	0.077	29.090	0.470	0.10		0.030			

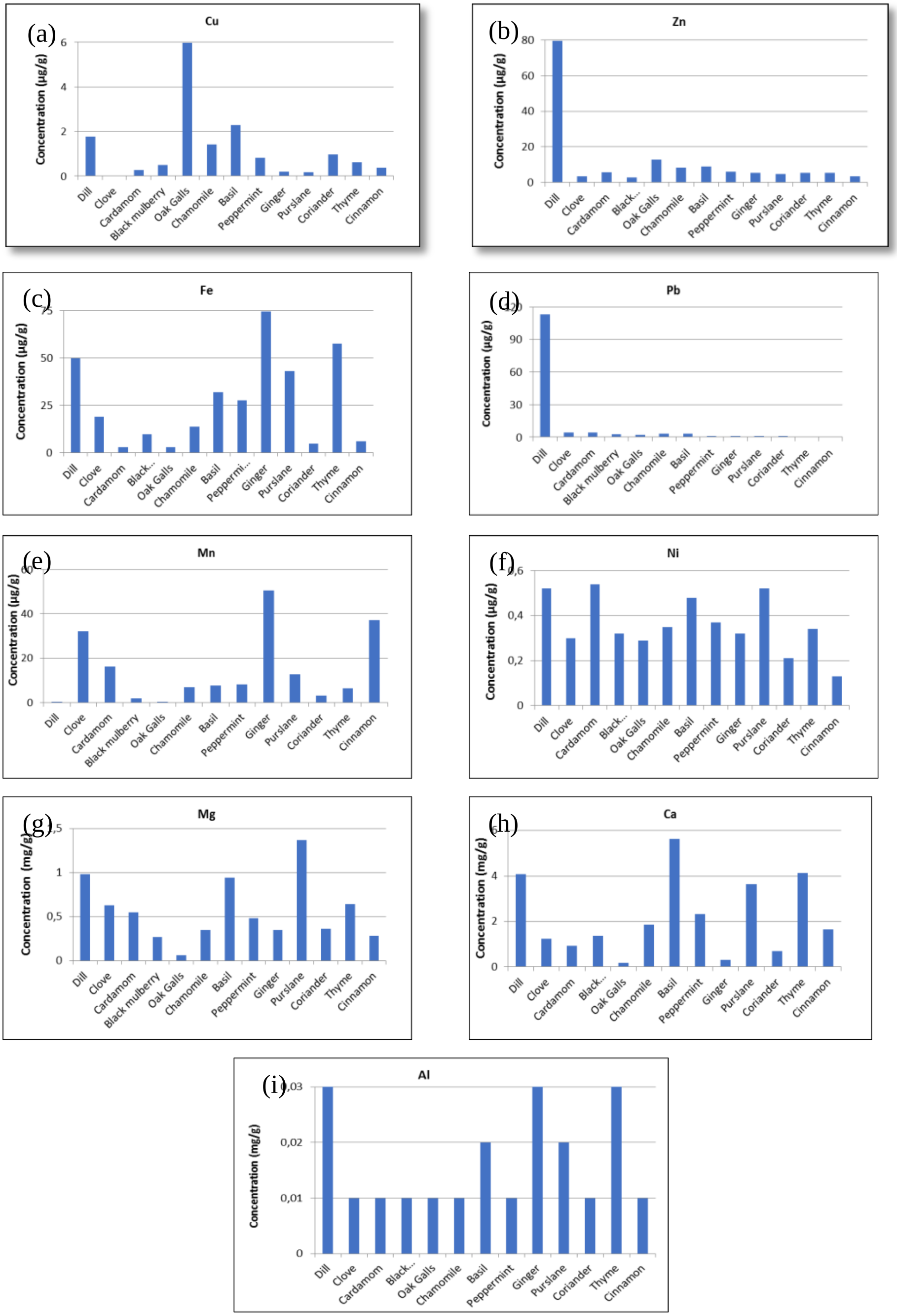

Figure 1. Distribution of trace and heavy elements ((a) Cu, (b) Zn, (c) Fe, (d) Pb, (e) Mn, (f) Ni, (g) Mg, (h) Ca and (i) Al) in plant Medicinal plants species

4. CONCLUSIONS

Medicinal plants are used both alone in the treatment of human diseases and as a raw material source in the preparation of various medicines. Therefore, determination of mineral and trace elements in plants is very important. The quality of many drugs and nutrients depends on both the content and the type of the elements [12].

In this work, the concentration of some essential and non-essential heavy metals were determined by using HR-CS AAS.

Table 2 and Table 3 Ca and Mg observed with the highest concentration in all the medicinal plants studied as compared to other trace elements recorded. The Pb level in the dill sample was found to be significantly higher compared to other studied samples and other plants in the literature (Fig. 1). The levels of Cu were relatively low in all medicinal plants. In general, the concentrations of minerals confirmed a positive present in all medicinal plants contribution.
Our research revealed that many of the trace elements found in the analyzed medicinal plants are within the limits of the Recommended Daily Intake (RNI) in the literature [29, 30].

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