Available online at www.sciencedirect.com
ScienceDirect
Food Chemistry 106 (2007) 852–858
Food Chemistry
www.elsevier.com/locate/foodchem

Analytical, Nutritional and Clinical Methods

Estimation of minerals, nitrate and nitrite contents of medicinal and aromatic plants used as spices, condiments and herbal tea

M.M. Özcan *, M. Akbulut

Department of Food Engineering, Faculty of Agriculture, University of Selcuk, 42031 Konya, Turkey

Received 31 May 2006; received in revised form 20 June 2007; accepted 23 June 2007

Abstract

In this study, the minor and major mineral contents of 31 kinds of medicinal and aromatic plant collected from the south region of Turkey in 2004 year were established by inductively coupled plasma atomic emission spectrometry (ICP-AES). The samples were composed of Al, Ca, Fe, K, Mg, Na, P and Zn. The highest mineral concentration were measured between 57.70–2962.74 mg/kg Al, 1160.04–16452.88 mg/kg Ca, 44.83–1799.5 mg/kg Fe, 3570.73–27669.72 mg/kg K, 477.17–4313.59 mg/kg Mg, 1102.62–20912.33 mg/kg Na, 443.60–9367.80 mg/kg P and 7.18–48.36 mg/kg Zn. The highest values of Ca, K and P were established in *F. vulgare* (bitter fennel) (16452.88 mg/kg), *O. minumum* (basil) (27669.72 mg/kg) and *F. vulgare* (bitter fennel) (9367.80 mg/kg), respectively. The heavy metal contents were determined too low in all samples.

Nitrate and nitrite contents of samples were analysed using the phenolicdisulphonic acid method and the diazotisation method of the American Public Health Association, respectively. These nitrate and nitrite values were established to vary widely depending on the different plant species. While nitrate contents were high in most cases and varied from 12.15 mg/kg lime flover (*Tilia corata*) to 238.85 mg/kg myrtle (*M. communis*), nitrite contents were established between 3.69 mg/kg sesame (*S. indicum*) to 52.70 mg/kg basil (*O. minumum*). Generally, nitrate contents of samples were found very high compared with nitrite values.

Keywords: Medicinal and aromatic plant; Minerals; Nitrate and nitrite contents

1. Introduction

Edible wild and culture plants are found in countries with rather varied climates. Plants greens and seeds were important foods in the traditional diet of the first European farmers. They consumed plants that today are no longer generally considered for nutrition (Guil, Martirey, & Irosa, 1998; Wells, 1984). Some modern culture still consume wild plants as a normal food source, obtaining fairly good amounts of several nutritients, and it is widely accepted that leafy green vegetables are significant nutritional sources of minerals (Kuhnlein, 1990). The main contrast for the nutritional exploitation of these species is the presence of certain anti-nutritional and toxic substances such as nitrates, oxalate, and saponin (Gupta & Wagle, 1998). Nevertheless, these principles are also found in commercial leafy green vegetables (Guil, Torija, & Rodriguez-Garcia, 1997).

Consumers are convinced that they need more and better nutrients than their diets provide. Nutritional deficiency may lead to diseases and nutritional deficiencies. Dietary supplements which increase the total dietary intake of one or more essential vitamin or minerals are very common (Ivey & Elmen, 1986; Obiajunwa, Adebajo, & Omobuwajo, 2002). Mixtures of medicinal plants are prescribed by the traditional healers for diseases ranging from common cold to maloria, arthritis, ulcers, etc. (Obiajunwa et al., 2002). Minor elements have very important functions and it is believed a key component of proteins such as haemoprotein and haemoglobin which play role in biochemical functions and essential enzyme system even in low doses. These

* Corresponding author.
E-mail address: mozcan@selcuk.edu.tr (M.M. Özcan).

0308-8146/$ - see front matter © 2007 Elsevier Ltd. All rights reserved.
doi:10.1016/j.foodchem.2007.06.045

elements are present in plants due to industrial development and pollution of biosphere (Chen, 1992; Hay, 1984; Tolonen, 1990). Most wild plants leaves are used in salad and meat product (Wetherilt, 1992). Many countries are rich in plants contained mineral and other nutrition elements (Freiberger et al., 1998; Khader & Rama, 1998; Yıldırım, Dursun, & Turan, 2001). Essential and trace element contents of 20 medicinal plants were determined in Niger. These elements were detected in concentrations between 0.182 and 77.400 ppm (Obiajunwa et al., 2002). Turan, Kordali, Zengin, Dursun, and Sezen (2003) reported macro- and micro-element contents of some wild culinary herbs in East Anatolian Region of Turkey. Also in other study, mineral contents of 32 plants used as condiments in Turkey were determined by inductively coupled plasma atomic emission spectrometry (ICP-AES) (Özcan, 2004).

Herbs and spices, grown wildly in various regions of the world, have been used for several purposes since ancient times. Several uses of these plants are known for culinary purposes. In addition, they are also used in folk medicine as antiscorbutic, antispasmodic, tonic, carminative agents against bronchitis, ulcers and as diuretics, depuratives, vermifurges. Also, some species are used as tea, flavouring agents in several regions (Baytop, 1984; Koedam, 1986; Yeşilada & Ezer, 1989). The nutritional and medicinal properties of these plants may be inter-link through phytochemicals, both nutrient and non-nutrient (Ranhotra, Leinen, Vinas, & Lorenz, 1998). Several studies have been carried out on edible wild plants (Chen, 1992; Guil et al., 1998; Özcan & Akgul, 1998; Özcan, Akgul, Bağcï, & Dural, 1998). But, limited studies were carried out on mineral, nitrate and nitrite contents of medicinal and aromatic plants growing in Turkey. So, it may be useful to know their content in the main edible plants collected for nutritional purposes in Turkey. The aim of this work was to establish the mineral, nitrate and nitrite contents of several herb and spices used for several purposes in Turkey.

2. Materials and methods

2.1. Materials

The plants used in experiment were collected from the south region of Turkey in June and July 2004 year. Sumac was harvested in September 2004. Blackpeper, cinnamon and clove were bought from local market. Fruit and seeds were collected during mature stage. Sampling technique was performed as replication. The dried materials were then ground in a mortar and the ground material sealed in bottles for storage until analysis. The common, scientific and family names of the plants are given in Table 1.

2.2. Methods

2.2.1. Determination of mineral contents

About 0.5 g dried and ground sample was put into a burning cup and 15 ml pure HNO_3 added. The sample was incinerated in a MARS 5 Microwave Oven at 200 °C and dissolved ash was diluted to a certain volume with ultra pure water. Concentrations were determined with an ICP-AES (Skujins, 1998).

Working conditions of the ICP-AES were

Instrument	ICP-AES (Varian-Vista 0.7–1.2 kW); (1.2–1.3 kW for axial)
Plasma gas flow rate (Ar)	10.5–15 l/min (radial); 15 l/min (axial)
Auxiliary gas flow rate (Ar)	1.5 l/min
Viewing height	5.12 mm
Copy and reading time	1–5 s (max 60 s)
Copy time	3 s (max 100 s)

Table 1
Medicinal and aromatic plants used in experiment

General name	Botanical name	Family	Used parts
Ajowan	*Carum copticum*	Umbelliferae	Fruit
Anise	*Pimpirella anisum* L.	Umbelliferae	Fruit
Balm	*Melissa officinalis*	Labiatae	Leave
Basil	*Ocimum minumum*	Labiatae	Leave + flower
Bitter fennel	*Foeniculum vulgare* ssp. *piperitum*	Umbelliferae	Fruit
Bitter fennel	*F. vulgare* ssp.*piperitum*	Umbelliferae	Leave
Black cumin	*Nigella sativa*	Ranunculaceae	Seed
Black pepper	*Piper nigrum*	Piperaceae	Fruit
Calamus	*Acorus calamus*	Araceae	Rhizom
Camomile	*Matricaria chamomilla*	Compositae	Flower
Caper	*Capparis ovata*	Capparaceae	Bud
Capsicum	*Capsicum frutescens*	Solanaceae	Fruit
Cinnamon	*Cinnamomum zeylanicum*	Lauraceae	Bark
Clove	*Syzygium aromaticum*	Myrtaceae	Flower
Cumin	*Cuminum cyminum*	Umbelliferae	Fruit
Fennel	*F. vulgare*	Umbelliferae	Fruit
Laurel	*Laurusnobilis*	Lauraceae	Leave
Lime flower	*Tilia cordata*	Tiliaceae	Leaf + flower
Liquorice	*Glycyrrhiza glabra* L.	Leguminasae	Root
Mint	*Mentha piperita* L.	Labiatae	Leave
Mustard	*Brassica alba*	Cruciferae	Seed
Myrtle	*Myrtus communis*	Myrtaceae	Leave
Pickling herb	*Echinophora tenuifolia*	Umbelliferae	Leave
Rosemary	*Rosmarinus officinalis*	Labiatae	Leave
Sage	*Salvia aucheri*	Labiatae	Leave
Sage	*Salvia fruticase* L.	Labiatae	Leave
Savory, sater	*Satureja hortensis*	Labiatae	Leave
Sesame	*Sesamum indicum*	Pedaliaceae	Seed
Sumac	*Rhus coriaria*	Aracordiaceae	Fruit
Thyme (black)	*Thymbra spicata* L.	Labiatae	Flower + leave
Wormwood	*Artemisia absinthium* L.	Compositae	Flower

2.2.2. Determination of nitrate and nitrite

The method of extraction of nitrite and nitrate of Stopes, Woodward, Frorde, and Vogtman (1998) was used. Ten grams each of the homogenized by drying and grinding was blended with 200 ml hot distilled water. The extract was kept in a refrigerator for 12 h and then filtered through Whatman No. 1 filter paper and the filtrate used for nitrate and nitrite determinations.

2.2.3. Nitrate determination

The filtrates as well as the water sample were analyzed for nitrate using the phenoldisulphonic acid method (Taras, 1950). Twenty milliliters of each sample filtrate was pipetted into a conical flask and the content evaporated to dryness. The residue was throughly wetted with 2 ml phenoldisulphonic acid reagent to ensure dissolution of all solids. It was then diluted with 20 ml distilled water and 6 ml concentrated ammonium hydroxide was added with stirring. Optical densities were read at 410 nm using a spectrophotometer (Shimadzu 160 A model, Japan) against a blank prepared with distilled water. A standard nitrate curve was prepared using sodium nitrate and sample concentrations were computed directly from the curve.

2.2.4. Nitrite determination

The diazotisation method of the American Public Health Association (1995) was used in the determination of nitrite. 25 ml of each sample filtrate was pipetted into a conical flask. A 0.5 ml sulphanillic acid reagent was added to each flask and left to stand for between 2 and 8 min. A 0.5 ml α-naphthylamine was then added and allowed to stand for about 2 h for the full development of the characteristic pinkish-red color. The optical densities were measured at a wavelength of 543 nm on a spectrophotometer against distilled water blank. A standard curve was prepared using sodium nitrite and sample nitrite concentrations were computed directly from curve.

2.3. Statistical analysis

Results were analysed for statistical significance by analyses of variance (Püskülcü & Ikiz, 1989). Analysis of variance and least significant difference tests were conducted to identify differences among means. Data were reported as mean ± standard deviation.

3. Results and discussion

3.1. Mineral contents of samples

Mineral contents of 31 samples of medicinal and aromatic plants consumed as spices, herbal tea and condiments in Turkey were established by using inductively coupled plasma atomic emission spectrometry (ICP-AES).

Eighteen minerals were determined in all samples. Mineral contents were determined to vary widely depending on the different species and locations of plants. Table 2 shows that medicinal and aromatic plants content considerably Al, Ca, Fe, K, Mg, Na, P and Zn. The highest mineral concentrations were measured between 57.70 and 2962.74 mg/kg Al, 1160.04 and 16452.88 mg/kg Ca, 44.83 and 1799.50 mg/kg Fe, 3570.73 and 27669.72 mg/kg K, 477.17 and 4313.59 mg/kg Mg, 1102.62 and 20912.33 mg/kg Na, 443.60 and 9367.80 mg/kg P and 7.18 and 48.36 mg/kg Zn. The heavy metal concentrations were found too low in all samples. Ca, K and P contents of samples in this study were established higher than those of other minerals. The highest values of Ca, K and P were established in bitter fennel leave (*F. vulgare*) (16452.88 mg/kg), basil (*O. minumum*) (27669.72 mg/kg) and bitter fennel leave (*F. vulgare*) (9367.80 mg/kg), respectively.

Aluminium contents were high in most cases and ranged from 57.70 mg/kg black cumin (*N. sativa*) to 2962.74 mg/kg anise (*P. anisum*). B content ranged from 0.87 mg/kg liquirica (*G. glabra*) to 47.67 mg/kg bitter fennel (*F. vulgare*). The highest content of Li was found in pickling herb (20.0 mg/kg). Mn contents were found to be very similar to that of other species. On the other hand, among these plants, Sr was found in large amounts in pickling herb (*E. tenuifolia*).

All parts such as young sheat, flower buds, fruit and seed of *C. ovata* plants contained high amounts of Ca, K, Mg, Na, P and Zn. The highest levels of Al, Ca, K, Mg, Na, P and Zn were found in caper seeds (Özcan, 2005). Püskülcü and Ikiz (1989) determined high amounts of Al, Ba, Ca, Fe, K, Mg, P and S. Also, Bi, Cd, Li, Pb and Se contents of condiments were found to be very low (Özcan, 2004). Also, amounts of phosphorus (19–48 mg/100 g), sodium (55–290 mg/100 g, potassium (280–670 mg/100 g), calcium (21–300 mg/100 g), magnesium (32–160 mg/100 g), iron (1.7–5.4 mg/100 g), copper (0.12–0.33 mg/100 g), manganese (0.2-1.00 mg/100 g) and zinc (0.41–1.20 mg/100 g) of edible wild plants were computed by Guil et al. (1998). Turan et al. (2003) determined Zn content of basil as 2.8 ppm in their study on mineral compositions of 26 different wild plants of East Anatolian Region. The macro- and micro-element values of wild plants in the same study were lower than the present study. Essential and trace element contents of 20 medical plants were determined in Niger. Elements such as K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Se, Br, Rb, Si, as well as toxic heavy metals such as Cd, As, Pb and Hg were detected in concentrations between 0.182 and 77400 ppm. Herb materials were found to contain any heavy metals such as Cd, As, Pb and Hg (Obiajunwa et al., 2002). Our some results of mineral contents of medicinal and aromatic plants used in experiment show minor differences when compared with literature (Akgül, 1993; Özcan & Akgul, 1998; Özcan et al., 1998; Özcan, 2004). These differences might be due to growth conditions, genetic factors, geographical variations and analytical procedures (Guil et al., 1998; Özcan & Akgul, 1998; Özcan, 2004).

High amounts of Ca are important because of its role in bones, teeth, muscle system and heart functions (Brody,

Table 2
Mineral contents in some spices

Spices	Minerals (ppm)								
	Al	B	Ca	Cd	Cr	Cu	Fe	K	Li
Ajowan	317.16[a] ± 23.98[b]	13.20 ± 4.36	14501.66 ± 745.25	0.75 ± 0.18	6.80 ± 1.47	8.63 ± 1.09	194.92 ± 22.95	15199.8 ± 334.93	2.19 ± 0.15
Anise	2962.74 ± 557.06	46.82 ± 9.87	6044.32 ± 360.11	0.66 ± 0.11	24.68 ± 7.36	6.04 ± 0.52	1799.5 ± 468.05	15471.88 ± 1100.48	5.76 ± 1.16
Balm	1758.28 ± 277.13	17.58 ± 4.61	11462.05 ± 2238.74	0.63 ± 0.06	11.62 ± 4.03	8.68 ± 0.99	907.57 ± 59.22	15821.60 ± 2196.53	2.91 ± 0.65
Basil	474.00 ± 71.35	12.51 ± 1.97	15759.92 ± 2510.34	0.78 ± 0.27	7.34 ± 0.54	7.61 ± 0.06	250.70 ± 38.21	27669.72 ± 2795.05	1.71 ± 0.61
Bitter fennel (leave)	708.48 ± 61.74	47.67 ± 12.88	16452.88 ± 2963.16	0.55 ± 0.18	11.33 ± 0.30	3.91 ± 0.45	328.68 ± 33.80	23988.87 ± 2297.81	2.04 ± 0.25
Bitter fennel (fruit)	163.35 ± 23.78	14.51 ± 0.39	10894.48 ± 2863.41	0.79 ± 0.15	6.79 ± 0.66	3.44 ± 0.28	72.04 ± 2.83	10692.61 ± 1560.91	1.46 ± 0.16
Black cumin	57.70 ± 30.47	8.93 ± 1.41	4599.21 ± 855.07	0.69 ± 0.37	3.86 ± 0.06	5.89 ± 1.17	71.21 ± 2.90	5626.25 ± 373.38	2.09 ± 0.62
Black pepper	167.67 ± 31.13	3.62 ± 0.91	2636.97 ± 302.43	0.79 ± 0.30	5.27 ± 0.24	4.78 ± 0.59	***89.24 ± 11.43	10006.04 ± 497.46	1.44 ± 0.52
Calamus	978.65 ± 98.57	9.75 ± 1.43	2658.41 ± 613.91	0.81 ± 0.04	16.92 ± 3.39	4.33 ± 0.81	706.52 ± 60.58	11447.42 ± 1169.93	1.97 ± 0.14
Camomile	296.97 ± 40.24	3.05 ± 1.75	5553.52 ± 888.38	1.05 ± 0.47	4.13 ± 1.25	2.11 ± 0.47	160.61 ± 18.94	10146.33 ± 540.30	1.93 ± 0.21
Caper	236.11 ± 29.40	15.35 ± 5.47	4138.71 ± 540.51	0.98 ± 0.10	8.43 ± 0.66	3.45 ± 0.66	164.08 ± 4.97	16544.61 ± 816.75	1.96 ± 0.38
Capsicum	129.63 ± 21.75	17.80 ± 1.22	1160.04 ± 223.06	0.71 ± 0.10	3.93 ± 1.30	3.84 ± 0.85	92.66 ± 4.27	20137.89 ± 1942.76	1.86 ± 0.56
Cinnamon	257.90 ± 33.62	23.79 ± 3.03	6018.78 ± 642.46	0.84 ± 0.11	7.89 ± 1.32	0	123.65 ± 7.63	5380.53 ± 162.80	1.44 ± 0.24
Clove	177.73 ± 9.97	12.36 ± 0.54	6500.09 ± 788.96	0.86 ± 0.45	5.54 ± 1.21	1.11 ± 0.18	64.75 ± 3.65	13140.83 ± 1671.37	1.62 ± 0.06
Cumin	1253.02 ± 146.87	12.69 ± 0.95	10050.19 ± 1829.23	0.59 ± 0.11	24.86 ± 4.30	2.78 ± 0.14	824.72 ± 68.01	12810.22 ± 1155.34	4.40 ± 1.69
Fennel	278.88 ± 31.45	19.63 ± 2.75	6745.76 ± 1021.88	0.50 ± 0.11	35.93 ± 9.12	8.28 ± 0.85	316.00 ± 35.47	16212.24 ± 2303.20	1.57 ± 0.34
Laurel	250.20 ± 20.32	10.58 ± 1.88	8946.52 ± 823.35	0.67 ± 0.09	4.33 ± 0.76	1.75 ± 0.41	126.38 ± 8.60	6461.82 ± 338.21	1.58 ± 0.55
Lime flower	593.45 ± 12.58	11.45 ± 3.55	4532.64 ± 519.04	0.66 ± 0.07	9.62 ± 1.12	3.82 ± 0.21	399.47 ± 49.82	8971.79 ± 576.47	1.87 ± 0.25
Liquorice	1251.45 ± 159.57	0.87 ± 0.11	10583.87 ± 1000.58	0.72 ± 0.25	13.80 ± 4.55	2.20 ± 046	893.61 ± 180.71	4094.03 ± 310.91	1.95 ± 0.38
Mint	433.88 ± 65.40	17.75 ± 2.88	4611.26 ± 1224.54	0.65 ± 0.30	7.17 ± 1.31	7.46 ± 1.41	230.36 ± 18.00	19292.01 ± 1870.54	1.95 ± 0.93
Mustard	97.36 ± 9.62	4.88 ± 2.02	2895.46 ± 777.83	0.89 ± 0.30	3.73 ± 0.94	1.14 ± 0.14	72.00 ± 8.27	6155.42 ± 563.88	1.59 ± 0.37
Myrtle	65.25 ± 5.22	12.40 ± 1.65	5639.70 ± 729.42	0.77 ± 0.10	2.66 ± 0.41	0	44.83 ± 8.64	5849.05 ± 540.17	1.57 ± 0.30
Pickling herb	548.51 ± 51.14	38.32 ± 12.54	12490.40 ± 1020.37	0.77 ± 0.28	7.81 ± 1.99	0.13 ± 0.04	370.52 ± 77.00	5106.05 ± 491.24	20.00 ± 1.92
Rosemary	1150.14 ± 142.10	21.14 ± 2.39	8605.25 ± 1907.53	0.73 ± 0.16	19.09 ± 4.82	3.01 ± 0.27	734.64 ± 38.55	11116.81 ± 1062.48	2.67 ± 0.28
Sage (*S. aucheri*)	200.48 ± 28.74	11.47 ± 1.44	8400.69 ± 2245.74	0.79 ± 0.44	5.44 ± 1.12	3.11 ± 0.14	98.33 ± 3.62	11176.94 ± 133.26	1.51 ± 0.55
Sage (*S. fruticase*)	530.25 ± 70.39	19.67 ± 2.93	6097.24 ± 1576.24	0.61 ± 0.10	8.52 ± 0.47	0.27 ± 0.07	330.44 ± 19.88	6674.55 ± 997.40	1.90 ± 0.01
Savory, sater	1251.93 ± 88.15	3.70 ± 2.43	14575.89 ± 1410.62	0.69 ± 0.10	10.08 ± 0.89	1.55 ± 0.18	630.20 ± 65.73	8840.91 ± 1083.61	2.84 ± 1.22
Sesame	102.81 ± 4.00	25.63 ± 5.58	5707.03 ± 386.00	0.56 ± 0.17	4.18 ± 0.27	11.00 ± 1.47	53.53 ± 10.30	3570.73 ± 289.91	1.36 ± 0.40
Sumac	430.94 ± 21.22	6.90 ± 1.61	2895.26 ± 777.79	0.61 ± 0.03	5.92 ± 1.29	0.12 ± 0.04	241.24 ± 51.13	10366.33 ± 535.39	1.95 ± 0.11
Thyme (black)	220.50 ± 28.32	12.82 ± 2.61	9582.54 ± 2664.80	0.76 ± 0.17	3.66 ± 0.96	1.90 ± 0.64	111.86 ± 12.86	11127.62 ± 1540.05	1.51 ± 0.38
Wormwood	92.60 ± 7.86	6.70 ± 1.10	871.91 ± 314.01	0.63 ± 0.17	3.32 ± 0.47	0	65.20 ± 5.71	5160.12 ± 1973.41	1.53 ± 0.23

(*continued on next page*)

Table 2 (*continued*)

Spices	Minerals (ppm)								
	Mg	Mn	Na	Ni	P	Pb	Sr	V	Zn
Ajowan	3044.45[a] ± 489.69[b]	43.68 ± 6.99	3129.20 ± 333.71	7.26 ± 0.48	9095.73 ± 899.61	0.69 ± 0.08	135.80 ± 14.42	42.29 ± 5.93	48.36 ± 8.45
Anise	3336.25 ± 242.49	76.72 ± 8.83	5832.73 ± 515.64	18.42 ± 2.12	12847.45 ± 2796.62	1.21 ± 0.45	56.49 ± 9.67	0	29.34 ± 11.32
Balm	2692.99 ± 251.83	33.05 ± 6.20	3113.03 ± 306.46	10.31 ± 0.54	6224.94 ± 673.33	1.29 ± 0.11	40.60 ± 3.81	11.69 ± 3.35	29.32 ± 8.42
Basil	3130.37 ± 443.11	23.61 ± 2.63	2894.71 ± 224.69	6.89 ± 0.14	8259.75 ± 397.41	0.61 ± 0.08	28.96 ± 0.51	40.92 ± 3.43	43.30 ± 1.42
Bitter fennel (leave)	2496.72 ± 322.41	46.86 ± 7.62	6684.39 ± 96.23	6.10 ± 0.60	9367.80 ± 543.15	0.17 ± 0.08	23.26 ± 3.09	32.31 ± 3.93	34.53 ± 7.17
Bitter fennel (fruit)	2097.63 ± 147.44	30.13 ± 2.95	2733.95 ± 190.96	3.44 ± 0.48	5746.82 ± 461.11	0.43 ± 0.11	10.53 ± 1.84	31.81 ± 4.91	21.07 ± 3.69
Black cumin	2150.31 ± 193.08	18.38 ± 1.97	1694.08 ± 238.18	4.82 ± 0.93	6507.90 ± 541.58	0.36 ± 0.15	21.70 ± 2.69	16.14 ± 2.99	36.34 ± 5.94
Black pepper	1486.94 ± 215.76	129.66 ± 22.76	1892.12 ± 279.46	4.74 ± 1.17	3266.91 ± 311.47	0.88 ± 0.14	12.17 ± 2.64	6.28 ± 1.37	9.25 ± 0.87
Calamus	875.44 ± 128.41	39.36 ± 4.85	4881.16 ± 321.43	3.56 ± 0.49	8037.21 ± 238.14	0.56 ± 0.07	24.13 ± 1.50	0	25.12 ± 4.10
Camomile	1171.18 ± 115.85	21.40 ± 4.07	1948.23 ± 76.36	2.16 ± 0.07	2575.31 ± 275.99	2.73 ± 0.14	4.31 ± 0.82	8.23 ± 1.48	19.57 ± 3.11
Caper	2298.95 ± 285.12	31.47 ± 1.18	1939.06 ± 159.41	7.38 ± 1.27	6677.25 ± 636.83	1.76 ± 0.37	30.80 ± 4.72	11.89 ± 3.40	34.04 ± 4.58
Capsicum	1253.65 ± 112.36	5.96 ± 0.20	16143.58 ± 398.61	2.20 ± 0.38	4577.18 ± 186.34	2.63 ± 0.26	2.65 ± 0.89	3.40 ± 0.95	14.04 ± 2.19
Cinnamon	668.79 ± 26.29	176.91 ± 19.09	2064.29 ± 141.18	4.09 ± 0.95	2480.94 ± 141.37	0	29.20 ± 2.88	9.04 ± 1.13	10.30 ± 1.48
Clove	2886.17 ± 122.10	529.54 ± 89.46	3797.71 ± 377.70	3.60 ± 0.83	3612.28 ± 462.97	1.37 ± 0.33	42.63 ± 5.85	21.96 ± 6.48	14.18 ± 1.71
Cumin	3169.17 ± 241.16	31.43 ± 2.87	3751.20 ± 110.19	27.04 ± 1.67	8452.51 ± 601.32	0.89 ± 0.28	66.06 ± 12.11	14.38 ± 7.12	16.48 ± 3.06
Fennel	3399.61 ± 382.41	33.39 ± 5.32	3228.55 ± 175.10	28.66 ± 1.38	8772.25 ± 878.93	0.35 ± 0.11	19.50 ± 2.22	24.97 ± 5.36	20.76 ± 4.78
Laurel	1289.91 ± 150.08	54.19 ± 7.53	1835.80 ± 100.62	2.28 ± 0.53	2571.40 ± 119.14	0	15.02 ± 1.18	19.32 ± 4.01	14.96 ± 1.99
Lime flower	2396.92 ± 186.67	64.30 ± 7.60	2349.57 ± 410.84	12.60 ± 2.14	4708.54 ± 652.02	0.43 ± 0.10	18.49 ± 2.77	5.56 ± 3.00	13.49 ± 1.48
Liquorice	2059.78 ± 264.34	19.92 ± 3.56	7636.10 ± 625.18	11.05 ± 1.93	3487.15 ± 430.65	0.78 ± 0.23	45.58 ± 5.17	11.24 ± 2.03	12.38 ± 3.11
Mint	2692.20 ± 32.91	34.28 ± 3.57	3020.09 ± 200.23	4.49 ± 0.98	6452.95 ± 322.93	0.72 ± 0.37	14.19 ± 2.75	8.77 ± 1.38	27.46 ± 3.60
Mustard	2705.34 ± 295.13	18.51 ± 0.83	1766.12 ± 128.69	1.81 ± 0.38	8883.30 ± 373.47	0.15 ± 0.06	9.76 ± 0.39	14.66 ± 1.39	38.33 ± 12.91
Myrtle	1937.00 ± 297.45	15.81 ± 2.09	983.66 ± 247.19	3.72 ± 0.68	443.60 ± 80.73	0	8.94 ± 1.00	18.44 ± 2.51	14.01 ± 3.46
Pickling herb	4313.59 ± 512.05	86.23 ± 9.45	2499.83 ± 340.32	7.69 ± 1.31	4047.49 ± 255.37	0.11 ± 0.12	699.38 ± 114.98	46.65 ± 6.15	9.23 ± 0.93
Rosemary	2407.70 ± 264.47	27.62 ± 3.04	4893.87 ± 396.22	7.66 ± 0.53	8205.07 ± 461.50	2.02 ± 0.17	67.42 ± 12.67	9.87 ± 0.16	31.24 ± 3.22
Sage (*S. aucheri*)	2504.99 ± 191.09	6.47 ± 0.52	2095.46 ± 324.41	3.30 ± 0.27	3082.80 ± 264.40	1.24 ± 0.22	19.03 ± 3.46	24.91 ± 7.98	16.58 ± 2.68
Sage (*S. fruticase*)	1726.66 ± 339.07	21.16 ± 3.32	2578.50 ± 309.86	4.69 ± 0.90	3654.80 ± 407.73	0.46 ± 0.14	15.39 ± 0.52	6.87 ± 2.93	18.68 ± 2.67
Savory, sater	2793.89 ± 134.38	24.27 ± 4.49	4143.54 ± 264.08	5.80 ± 1.24	6216.84 ± 664.71	1.28 ± 0.42	19.16 ± 2.30	19.19 ± 4.14	23.60 ± 2.68
Sesame	2639.51 ± 241.25	11.06 ± 1.82	2234.37 ± 191.51	3.21 ± 0.52	7878.74 ± 538.83	0.02 ± 0.03	30.94 ± 0.42	20.92 ± 3.69	54.48 ± 8.24
Sumac	477.17 ± 30.78	7.00 ± 1.27	20912.33 ± 2706.51	2.81 ± 0.65	1819.08 ± 109.97	0.93 ± 0.34	13.53 ± 1.50	1.50 ± 0.38	7.18 ± 0.44
Thyme (black)	1525.33 ± 143.81	45.75 ± 9.32	1683.42 ± 372.35	2.29 ± 0.55	1896.23 ± 379.08	1.59 ± 0.38	6.12 ± 0.79	21.73 ± 4.31	17.47 ± 4.47
Wormwood	788.87 ± 0.42	6.99 ± 1.51	1102.62 ± 154.20	2.23 ± 0.25	1528.63 ± 193.11	0.32 ± 0.24	2.03 ± 0.75	1.80 ± 1.44	10.79 ± 2.18

[a] Mean.
[b] Standard deviation.

1994). Iron is an important element for human body and plays a role in oxygen and electron transfer. It is necessary for the formation of haemoglobin (Dalziel, 1936; Kaya & İncekara, 2000). Lead and Cadmium cause both acute and chronic poisoning, adverse effects on the kidney, liver, heart, vascular and immune system (Heyes, 1997). Copper and Zinc are required in our diet because they exhibited a wide range of biological functions such as components of enzymatic and redox systems (McLaughlin M, Parker, & Clarke, 1999). Decreasing of these toxic element contents is an advantage. Lithium another element with Benefical pharmacological properties; it has been used effectively in the treatment of manic depressive disorders. There is evidence to suggest that lithium is also an essential element (Macrae, Robinson, & Sadler, 1993).

The results also show that many of these plants contain elements of vital importance in man's metabolism and that are needed for growth and developments prevention and healing of diseases (Obiajunwa et al., 2002). This study attempts to contribute to knowledge of the nutritional properties of some medicinal and aromatic plants growing wild in Turkey. In addition, knowledge of the mineral contents, as aromatic plants is of great interest. In conclusion, medicinal and aromatic plants were found to be important sources of nutrients and essential elements.

3.2. Nitrate and nitrite contents of samples

Nitrate and nitrite contents of plant materials are given in Table 3. These values were established to vary widely depending on the different plant species.

While nitrate contents were high in most cases and varied from 12.15 mg/kg lime flower (*T.cordata*) to 238.85 mg/kg myrtle (*M.communis*), nitrite contents were established between 3.69 mg/kg sesae (*S. indicum*) to 52.70 mg/kg basil (*O. minimum*). The highest nitrate contents were found in myrtle (238.85 mg/kg), basil (174.26 mg/kg), sumac (162.28 mg/kg), sater (137.79 mg/kg) and cumin (84.95 mg/kg). However, nitrite contents of myrtle, basil, sumac, sater, bitter fennel and pickling herb were determined as 30.26, 52.70, 36.60, 46.51, 22.53 and 22.06 mg/kg, respectively. Generally, nitrate contents of all samples were found very high compared with nitrite values.

Nitrate and nitrite amounts of foods are of great importance regarding the consumers' health excessive nitrate accumulation can occur in some leaf and root vegetables (Şahin, Çopur, Korukoğlu, & Göçmen, 1995). According to Taras (1950), nitrate contents were average 20421 mg/kg in white radish, 10919 mg/kg in celery, 7933 mg/kg in black radish, 7266 mg/kg in red radish, 6479 mg/kg in carrot, 2797 mg/kg in cauliflower, 2543 mg/kg in pink radish. The same researchers were established nitrite contents as 127 mg/kg in carrot, 85 mg/kg in black radish, 78 mg/kg in white radish, 92 mg/kg in red radish, 44 mg/kg in pink radish, 166 mg/kg in celery, 82 mg/kg in turnip and 146 mg/kg in cauliflower. Buckenhuskes & Gierschner (1987) reported as 62–664 mg/kg nitrate contents of cauliflower. Tekeli, Güneş, & Gürses (1972) established between 207 and 2865 mg/kg the nitrate contents of spinach leaves. Çopur (1995) determined 307–411 mg/kg and 279–318 mg/kg nitrate in spinach collected from two locations, respectively. FAO/WHO fixed an allowable daily intake of $NaNO_3$ of 5 mg or NO_3 of 3.65 mg of body weight. These values for nitrite are 0.2 mg $NaNO_2$ or 0.133 mg NO_2 (Russel & Gould, 1991). Our results were found very low compared with literature values. The nitrate contents of agriculture products vary depending on plant species, fertilization form and amount and harvested time, use together with organic fertilizer of industry fertilizer (Buckenhuskes & Gierschner, 1988; Fidan, Sürmeli, & Genç, 1993; Öndeş & Zabunoğlu, 1991). As a result, fertization form and amounts are to high nitrate contents of agriculture products according to literature findings.

Table 3
Nitrate and Nitrite contents in some species

Spices	Content (mean ± SD, *n*:3) (mg/kg d.w.)	
	Nitrate	Nitrite
Ajowan	nd	nd
Anise	38.98[a] ± 0.64[b]	11.67 ± 0.56
Balm	Nd	nd
Basil	174.26 ± 24.25	52.70 ± 7.72
Bitter fennel (leave)	nd	nd
Bitter fennel (fruit)	38.75 ± 1.49	22.53 ± 0.60
Black cumin	nd	nd
Black pepper	nd	nd
Calamus	15.24 ± 1.64	8.80 ± 1.64
Camomile	nd	nd
Caper	12.17 ± 0.40	6.81 ± 0.61
Capsicum	63.11 ± 1.95	nd
Cinnamon	74.08 ± 3.45	6.95 ± 0.78
Clove	nd	nd
Cumin	84.95 ± 1.56	nd
Fennel	38.07 ± 3.33	nd
Laurel	40.11 ± 1.35	17.67 ± 0.87
Lime flower	12.15 ± 0.29	5.11 ± 0.18
Liquorice	nd	nd
Mint	nd	nd
Mustard	44.74 ± 1.87	19.54 ± 1.48
Myrtle	238.85 ± 2.65	30.26 ± 1.79
Pickling herb	56.51 ± 2.06	22.06 ± 3.10
Rosemary	nd	nd
Sage (*Salvia aucheri)*	30.60 ± 1.49	8.35 ± 1.41
Sage (*Salvia fruticase* L.)	46.27 ± 3.95	16.95 ± 0.78
Savory, sater	137.79 ± 3.95	46.51 ± 1.26
Sesame	16.15 ± 0.29	3.69 ± 0.05
Sumac	162.28 ± 3.27	36.60 ± 2.57
Thyme (black)	nd	nd
Wormwood	nd	nd

nd: not detected
[a] Mean.
[b] Standard deviation.

Acknowledgement

This work was supported by Selçuk Üniversity Scientific Research Project (S.Ü.-BAP, Konya, Turkey).

References

Akgül, A. (1993). *Spice science and technology*. Turkish Association Food Technologists Publ. No. 15. Ankara, Turkey [in Turkish].

American Public Health Association (1995). *Standard methods for the examination of water and waste water* (17th ed.) p. II 93.

Baytop, T. (1984). *Treatment with plants in Turkey (İstanbul Univ. Publ. No: 3255)*. İstanbul: İstanbul University [in Turkish].

Brody, T. (1994). *Nutritional biochemistry*. San Diego, CA: Academic Press.

Buckenhuskes, H., & Gierschner, K. (1987). Charakterisierung von laktofermentierten gemüsesaeften aus dem haldel. *Flüssiges Obst., 54*(2), 72–81.

Buckenhuskes, H., & Gierschner, K. (1988). Nitrat in roten beten (Beta vulgaris Lssp. vulgaris var. londitiva Alef). *Industrielle Obst. Und Gemüseverwertung, 73*(3), 75–83.

Chen, Z. S. (1992). Metal contamination of flooded soils, rice plants and surface water in Asia. In D. C. Adriano (Ed.), *Biogeochemistry of trace metals* (pp. 85). Publishers Inc.: Lewis.

Çopur, U. (1995). Bursa yöresinde yetiştirilen marul ve ispanaklarda nitrat ve nitrit miktarlari ile diğer kalite kriterlerinin belirlenmesi üzerinde bir araştirma. *Yüksek Lisans Tezi*, 56 s, Uludağ Universitesi Fen Bilimleri t Enstitüsü, Bursa.

Dalziel, J. M. (1936). *The useful plants of west tropical Africa*. London: The Crown Agents for the Overseas Governments and Administrations.

Fidan, F., Sürmeli, N., & Genç, C. (1993). Tarim ve Köyişleri Bakanliği. *Tarimsal Araştirmalar Genel Müdürlüğü Atatürk Bahçe Kültürleri Araştirma Enstitüsü* (p. 39), Turkey: Yalova.

Freiberger, C. E., Vanderjagt, D. I., Pastuszyn, A., Glew, R. S., Mounkaila, G., Millson, M., et al. (1998). Nutrient content of the edible leaves of seven wild plants from Niger. *Plant Foods for Human Nutrition, 53*(1), 57–69.

Guil, J. L., Martirey, J. J. G., & Irosa, M. E. T. (1998). Mineral nutrient composition of edible wild plants. *Journal of Food Composition and Analysis, 11*, 322–328.

Guil, J. L., Torija, M. E., & Rodriguez-Garcia, I. (1997). Nutritional and toxic factors in selected wild edible plants. *Plant Foods for Human Nutrition, 51*, 99–107.

Gupta, K., & Wagle, D. S. (1998). Nutritional and antinutritional factors of greenleafy vegetables. *Journal of Agricultural and Food Chemistry, 36*, 472–474.

Hay, R. W. (1984). *Bio-inorganic chemistry*. Chichester, England: Ellis Harwood Ltd.

Heyes, R. B. (1997). The carcinogenicity of metals in humans. *Cancer Causes and Control, 8*, 371–385.

Ivey, M., & Elmen, G. (1986). *Handbook of nonprescription drugs* (8th ed.). The National Profess. Society Pharm., 2215 Constitution Avenue, N.W., Washington, DC 20037, USA: Am. Pharm. Assoc., p. 215.

Kaya, İ, & İncekara, N. (2000). Contents of some wild plants species consumed as food in Aegean region. *The Journal of Turkish Weed Science, 3*, 56–64.

Khader, V., & Rama, S. (1998). Selected mineral content of common leafy vegetables consumed in India at different stages of maturity. *Plant Foods for Human Nutrition, 53*(1), 71–81.

Koedam, A. (1986). Volatile oil composition of Grek mountain tea (*Sideritis* spp.). *Journal of the Science of Food and Agriculture, 36*, 81–684.

Kuhnlein, H. V. (1990). Nutrient values in indigenous wild plant greens and roots used by the Nuxalle people of Bela Coole, British Colombia. *Journal of Food Composition and Analysis, 3*, 38–46.

Macrae, R., Robinson, R. K., & Sadler, M. J. (1993). *Encyclopedia of food science food technology and nutrition* (vol. 7). San Diego, CA: Academic Press Inc.

McLaughlin M, M. J., Parker, D. R., & Clarke, J. M. (1999). Metals and micronutrients-food safety issues. *Field Crops Research, 60*, 143–163.

Obiajunwa, E. I., Adebajo, A. C., & Omobuwajo, O. R. (2002). Essential and trace element contents of some Nigerian medicinal plants. *Journal of Radioanalytical and Nuclear Chemistry, 252*(3), 473–476.

Öndeş, A. D., & Zabunoğlu, S. (1991). Azotlu gübrelerin sebzelerde nitrat birikimine etkisi. *Doğa, 15*, 445–460.

Özcan, M. (2004). Mineral contents of some plants used as condiments in Turkey. *Food Chemistry, 84*, 437–440.

Özcan, M. (2005). Mineral composition of different parts of *Capparis ovata* Desfvar. canescens (Coss.) Heywood growing wild in Turkey. *Journal of Medicinal Food, 8*(3), 405–407.

Özcan, M., & Akgul, A. (1998). Influence of species, harvets date and size on composition of capers (*Capparis* spp.) flower buds. *Nahrung, 42*, 102–105.

Özcan, M., Akgul, A., Bağcï, Y., & Dural, H. (1998). Chemical composition and mineral contents of edible wild plabts consumed in İçel (Mersin). *S.U. Science Journal, 15*, 72–77.

Püskülcü, H., & İkiz, F. (1989). *Introduction to statistics*. Bornova-İzmir: Bilgehan Press [in Turkish].

Ranhotra, G. S. J. A., Leinen, S. D., Vinas, M. A., & Lorenz, K. J. (1998). Nutritional profile of some edible plants from Mexico. *Journal of Food Composition and Analysis, 11*, 298–304.

Russel, N. J. & Gould, G. W. (1991). *Food preservatives* (p. 290). Blackie Glasgow and London. Pub. USA by AVI an imprint of Von Nostrand Reinhold New York.

Şahin, İ., Çopur, U., Korukoğlu, M., & Göçmen, D. (1995). Havuç, turp, kereviz, şalgam ve karnabaharlarin nitrat ve nitrit miktari üzerinde araştirma. *Uludağ Üniversiti Ziraat Fakültesi Dergisi, 11*, 1–27.

Skujins, S. (1998). *Handbook for ICP-AES (Varian-Vista)*. A short guide to vista series ICP-AES operation. Version 1.0, Varian Int. AG, Zug.

Stopes, C., Woodward, L., Frorde, G., & Vogtman, H. (1998). The nitrate content of vegetable and salads crops offered to consumer. *Biological Agriculture and Horticulture, 5*(3), 215–221.

Taras, J. M. (1950). Phenoldisulphonic acid metod of determining nitrate in water. *The Journal of Analytical Chemistry, 22*(8), 1020–1022.

Tekeli, S. T., Güneş, S. T., & Gürses, Ö. L. (1972). Türkiye'de yetiştirilen ispanaklarin nitrat miktarlari üzerinde araştirmalar. *Ankara Üniversitesi Ziraat Fakültesi Yilliği, 22*(3-4), 340–347.

Tolonen, M. (1990). *Vitamins and minerals in health and nutrition ellis horwood limited*. Berlin: Sage.

Turan, M., Kordali, Ş., Zengin, H., Dursun, A., & Sezen, Y. (2003). Macro- and micro-mineral content of some wild edible leawes consumed in Eastern Anatolia. *Soil and Plant Science, 53*, 129–137.

Wells, P. S. (1984). Una comunidad agricola de la edad del hierro en la Europa Central. *Investigacion Ciencia, 89*, 30–37.

Wetherilt, H. (1992). Evaluation of urtica species as potential sources of important nutritients. *Food Science and Human Nutrition, 29*, 15–26.

Yeşilada, E., & Ezer, N. (1989). The antiinflammatory activity of some Sideritis species growing in Turkey. *Journal of Crude Drug Research, 27*, 38–40.

Yildirim, E., Dursun, A., & Turan, M. (2001). Determination of the nutrition contents of the wild plants used as vegetables in upper Çoruh valley. *Turkish Journal of Botany, 25*, 367–371.