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ARTICLE

Nutritional properties, minerals, and selected heavy metal contents in herby cheese plants of Lamiaceae

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Abstract Ten of the most popular and well-known edible plant species from the Lamiaceae which are used in the production of herby cheese were examined to evaluate their nutritional properties, mineral, and heavy metal content. This study has revealed significant variations in the contents of minerals among the studied plant species. The most of plant samples were rich in some of the vital minerals such as Fe, Cu, Ca, K, Mn, and Zn, which are known to be important in health maintenance. *Ziziphora capitata* plant materials had the highest concentration of toxic heavy metals, including chromium (1.72 mg kg^{-1}), where *Mentha longifolia* had the highest cobalt (1.14 mg kg^{-1}). The results of this study suggest that the use of these plant species in herby cheese will not contribute to heavy metal toxicity, but may be useful in treating micronutrient deficiency.

Keywords Aromatic herbs · Heavy metal toxicity · Nutritional minerals

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Introduction

Turkey is known as an important gene center of many cultivated crops whose wild ancestors can still be found in the extraordinary rich flora of Anatolia. The main part of Turkey, Anatolia, which has a rich flora due to its variable climate and its various ecological zones, is the origin of many medicinal plants. Anatolia is also regarded as a major center of diversity of the Lamiaceae (Labiatae) family (Kocabas and Karaman 2001). In Turkey, the family is represented with 45 genera, 546 species, and a total of 731 taxa, of which 256 species are endemic (44.2%). In terms of endemism, the Lamiaceae is the third richest family in Turkey (Başer 1993).

The wild edible plants of this eastern Anatolia have been used since early times for several purposes. One of these uses is the preparation of herby cheese, a traditional and semi-hard type of salty Turkish cheese. It is generally prepared by adding some aromatic herbs, which are well known for more than 200 years in Turkey, especially in the eastern and southeastern regions of Anatolia. The plant species vary from region to region the most popular herbs belong to the Liliaceae, Apiaceae, and Lamiaceae. These herbs are added to cheese in different ratios (0.1–15%) in order to provide special flavors and aromas (Arzu et al. 2013). In addition, these herbs provide bio-preservative characteristics to the cheeses (Tarakci and Kucukoner 2008).

The antibacterial, antioxidant (Dagdelen et al. 2014), and antifungal (Moro et al. 2013) properties of herbs used in the preparation of herbal cheeses have been studied. There has been some concern regarding toxic heavy metal concentrations in Spanish (Moreno-Rojas et al. 2010), Lebanese (Khozam et al. 2012), as well as Turkish cheeses (Tarakci and Kucukoner 2008). However, the mineral content of herbs used in the manufacture of herbal cheeses has received less attention. The purpose of this study, therefore, was to determine the basic nutrients, concentrations of beneficial mineral micronutrients, and potentially hazardous concentrations of metal ions.

Materials and methods

Plant materials

The plants used in this study were collected during the flowering and fruiting stages from the Van Lake district in eastern Anatolia in 2014. The collected plants were placed in paper bags and stored in an ice box during transport to the laboratory (about 3 h). The plants were air dried in the shade. Herbarium samples were prepared and the plants were botanically characterized by Dr. Fevzi Ozgokce and Dr. Murat Unal, according to the morphological description presented in Turkey flora (Davis 1972). The characteristics of these species are given in Table 1. For each plant, the sample was cleaned of foreign debris by hand, and the useful parts for herby cheese were separated, washed with deionized water, air dried at room temperature, and pulverized using an agate mortar and pestle for chemical analysis. The ground samples were then packed in plastic bags and stored in a desiccator until analysis.

Chemical analysis

The determination of dry matter content of the samples was performed according to the AOAC 2000 Official Method 4.1.06 dry matter procedure. Total ash of samples was analyzed under the conditions of AOAC 2000 Official Methods 3.4.11 total ash procedure. pH was measured using a digital pH-meter, according to AOAC 1996 Official Method 981.12 and identification of crude fiber performed under controlled conditions of AOAC 2000 Official Method 962.09 of crude fiber procedure. The protein content of samples has been identified on the basis of total nitrogen content, while the Kjeldahl (or similar) method has been almost universally applied to determine the nitrogen content. The factor (6.25) was used for all cases to calculate protein content AOAC 2000 Official Method 954.01.

Determination of mineral content

Concentrations of metals sodium (Na), magnesium (Mg), potassium (K), calcium (Ca), manganese (Mn), iron (Fe), copper (Cu), zinc (Zn), chromium (Cr), and cobalt (Co) in the powdered herb samples were determined using the Inductively Coupled Plasma-Atomic Emission Spectroscopic (ICP/AES) apparatus under conditions of AOAC 2000 Official Method 984.27. Phosphorus (P) and sulfur (S) were determined using molybdate–vanadate method in conjugation with a UV–Visible spectrophotometer (Shimadzu UV-1201 V; Shimadzu, Kyoto, Japan).

Statistical analysis

The analyses were performed in triplicate and data are presented as mean ± SD with one-way analysis of variance at $P < 0.05$ significance level, which was performed

Table 1 Samples used as edible wild plants in herby cheese in Eastern Anatolia

Plant	Local name	Parts used	Locality	Col. no
Mentha longifolia L.	Punk, Nane	Leaf	L10	MF 2422
Mentha spicata L. subsp. *spicata*			L6	–
Ocimum basilicum L.	Fesleğen	Leaf	L9	–
Thymus fallax Fisch & C.A. Mey.	Kekik, çatır, catri	Leaf	L2	OK 488
Thymus kotschyanus Boiss. & Hohen. subsp. *kotschyanus*	Kekik, çatır, catri		L8	OK 6280
Thymus migricus Klokov & Des.-Shost.	Kekik, çatır, catri	Leaf	L5	F1 0971
Thymus praecox Opiz	Kekik	Leaf	L4	MF 2062
Thymus transcaucasicus Ronniger	Kekik, çatır, catri	Leaf	L3	MF 493
Ziziphora capitata L.	Keklik otu	Leaf	L1	ÇFKO 0949
Ziziphora clinopodioides Lam.	Keklikotu	Leaf	L7	MF 390

L1, B9; Van Yuzuncu Yıl University, North of Indoor Sports Hall 38° 34′ 139″ N, 43° 16′ 670″ E, 1679 m, ÇFKO 0949 (no: 31); **L2**, B9; Van, Erciş, the steppe between İşbaşı-Hasanabdal villages 39° 11′ 254″ N, 43° 21′ 516″ E, 1750 m, OK 488 (no: 36); **L3**, B9; Van, Gürpınar, Özlüce village, steppe 38° 04′ 228″ N, 43° 26′ 391″ E, 2100 m, MF 493 (no: 36); **L4**, C9; Gürpınar, north of Akdoğu village, steppe, 37° 50′ 934″ N, 43° 22′ 527″ E, 2500 m, MF 2062 (no: 36); **L5**, B9; Bitlis/Van, northwest slopes of Alacabük Mountain, from İnköyü (2640 m) toward to the top (2870 m), 38° 25′ 220″ N and 42° 45′ 302″ E, F10971 (no: 36); **L6**, It is cultivated; **L7**, C9; Van Gürpınar, the steppe of Topçu değirmeni and Yalınca villages' crossroads, 37° 57′ 370″ N, 45° 35′ 984″ E, 2269 m, MF 390 (no: 41); **L8**, B9; Van, Erciş, the steppe of around Altındere hara, 39° 09′ 786 N 43° 21′ 139″ E, 1810 m, OK 6280 (no: 36); **L9**, It is cultivated; **L10**, C9, Van Gürpınar, meadowy place in north of Topçu değirmeni village. 37° 48′ 182 N, 43° 33′ 539″ E, 2360 m, MF2422 (no: 39) with statistical software (CoStat version 6.303, 1998–2004 CoHort Software, USA). The least significant difference (LSD) test was used to compare the differences between the means statistically.

Results and discussion

The basic nutrients, mineral, and metal contents of the Lamiaceae species in this study are summarized in Tables 2, 3, 4, 5, 6, and 7 with LSD and coefficient of variation (CV) values. The plant species was the major discerning factor affecting all of the observed parameters. According to the results of variance analysis, there was a significant ($P < 0.05$) variation between plant species with respect to all of the basic nutrients, minerals, and metal contents.

There is a wide diversity among mineral and metal ion concentrations of the plants analyzed in this study. However, most of these plant species were rich in the following essential minerals: K, Ca, Mn, Zn, Fe, Cu. These minerals are essential components of tissues because of their numerous roles, importance in proper functioning of enzyme systems, nerve conduction and muscle function, assisting with the transfer of nourishment into cells, providing the framework for tissues, and regulation of organ functions (Bhat et al. 2010).

The sodium ion concentrations of the analyzed plant samples varied from 0.50 to 0.87 g kg^{-1} (Table 2). *Ocimum basilicum* had the highest levels of Na (0.87 g kg^{-1}), whereas *Thymus transcaucasicus* had the lowest content (0.50 g kg^{-1}). These values lie within the range recorded for some other plant species (0.32–1.26 g kg^{-1}) (Tunctürk and Özgökçe 2015). However, the sodium concentration in *O. basilicum* was high compared to previously reported *O. basilicum* samples (Özcan et al. 2008) which average around 0.26 g kg^{-1}.

The magnesium contents of the plant samples showed variations between 2.13 and 5.46 g kg^{-1} values (Table 2), where the highest mean value was observed from *O. basilicum* (5.46 g kg^{-1}) and the lowest was obtained from *Thymus migricus* (2.13 g kg^{-1}), respectively. Both *Mentha longifolia* and *Mentha spicata* had Mg^{2+} comparable to those observed in *Mentha piperita* (Özcan et al. 2008).

All the analyzed plant samples had considerable phosphorus concentrations, with *O. basilicum* showing the highest P levels (4.32 g kg^{-1}) and *Thymus fallax* showing the lowest (1.50 g kg^{-1}) (Table 2). The lower range for phosphorus concentrations (1.2–2.9 g kg^{-1}) was reported by Ramírez-Orduña et al. (2005) for native legumes and non-legumes growing in Baja California, Mexico. Both *M. longifolia* and *M. spicata* had phosphorus concentrations comparable to other *Mentha* spp. (2.29–4.55 g kg^{-1}) (Özcan et al. 2008). Likewise, the phosphorus concentration in *O. basilicum* was comparable to those previously reported for this species (4.96–8.43 g kg^{-1}) (Özcan et al. 2008).

Potassium is an activator of some enzymes and is essential for normal growth and muscle functions (Lokhande et al. 2009). As shown in Table 3, *O. basilicum* had the highest potassium concentration (25.91 g kg^{-1}) and *T. migricus* had the lowest (12.56 g kg^{-1}). The potassium concentration in *M. longifolia* was comparable to K^{+} in *M. piperita* from Turkey (18.5 g kg^{-1}) (Özcan et al. 2008), and K^{+} in *O. basilicum* was very close to *O. basilicum*, reported previously by Özcan (2004). The *Thymus* spp. showed K^{+} ranging from 12.56 g kg^{-1} (*T. migricus*) to 18.51 g kg^{-1} (*Thymus kotschyanus*).

Table 2 Sodium, magnesium, and phosphorus contents of wild edible plants in Eastern Anatolia, Turkey

Plant names	Na (g kg^{-1})	Mg (g kg^{-1})	P (g kg^{-1})
Mentha longifolia L.	0.58 ± 0.01e*	2.58 ± 0.37f	17.43 ± 0.25cd
Mentha spicata L. subsp. *Spicata*	0.63 ± 0.01d	4.24 ± 0.29bc	16.75 ± 0.81c
Ocimum basilicum L.	0.87 ±0.02a	5.46 ± 0.13a	19.04 ± 0.26a
Thymus fallax Fisch & C.A.Mey.	0.82 ± 0.01f	2.16 ±0.19g	15.32 ± 0.67f
Thymus kotschyanus Boiss. & Hohen. subsp. *kotschyanus*	0.53 ± 0.01b	3.89 ± 0.04cd	19.32 ± 0.17de
Thymus migricus Klokov & Des.-Shost.	0.51 ± 0.01f	2.13 ± 0.2g	10.45 ± 0.13e
Thymus praecox Opiz	0.58 ± 0.00e	4.29 ± 0.04b	10.89 ± 0.09e
Thymus transcaucasicus Ronniger	0.51 ± 0.01f	3.38 ± 0.22e	8.74 ± 0.92b
Ziziphora capitata L.	0.78 ± 0.00c	3.63 ± 0.09de	35.69 ± 0.75b
Ziziphora clinopodioides Lam.	0.60 ± 0.05de	2.87 ± 0.24f	21.1 ± 1.74de
LSD (0.05)**	0.03	0.37	1.35
CV	3.16	6.25	4.50

* The letters indicate differences ($P < 0.05$) between means

** The least significant difference

Table 3 Potassium, sulfur, and calcium contents of wild edible plants in Eastern Anatolia, Turkey

Plant names	K (g kg^{-1})	S (g kg^{-1})	Ca (g kg^{-1})
Mentha longifolia L.	21.13 ± 0.75b*	1.68 ± 0.10c	2.67 ± 0.10d
Mentha spicata L. subsp. *Spicata*	20.65 ± 0.42b	2.88 ± 0.09a	2.83 ± 0.01d
Ocimum basilicum L.	25.91 ± 0.44a	1.39 ± 0.05d	4.32 ± 0.12c
Thymus fallax Fisch & C.A.Mey.	14.67 ± 0.85de	1.37 ± 0.37d	1.50 ± 0.10e
Thymus kotschyanus Boiss. & Hohen. subsp. *kotschyanus*	18.51 ± 0.37c	1.32 ± 0.06d	2.41 ± 0.18c
Thymus migricus Klokov & Des.-Shost.	12.56 ± 0.70f	1.35 ± 0.10d	2.25 ± 0.13f
Thymus praecox Opiz	13.72 ± 0.79ef	1.35 ± 0.26d	2.26 ± 0.06f
Thymus transcaucasicus Ronniger	14.50 ± 0.99de	1.44 ± 0.10d	3.37 ± 0.39g
Ziziphora capitata L.	20.47 ± 0.36b	2.10 ± 0.04b	3.30 ± 0.26a
Ziziphora clinopodioides Lam.	15.43 ± 1.23d	1.92 ± 0.05b	2.42 ± 0.10b
LSD (0.05)**	1.23	0.22	0.30
CV	4.05	7.66	6.41

* The letters indicate differences ($P < 0.05$) between means

** The least significant difference

Table 4 Manganese, iron, and chromium contents of wild edible plants in Eastern Anatolia, Turkey

Plant names	Mn (mg kg^{-1})	Fe (mg kg^{-1})	Cr (mg kg^{-1})
Mentha longifolia L.	55.70 ± 1.85e*	283.23 ± 29.84de	ND
Mentha spicata L. subsp. *Spicata*	79.10 ± 2.30c	246.98 ± 14.51f	ND
Ocimum basilicum L.	48.38 ± 0.62f	260.52 ± 22.34ef	1.00 ± 0.12b
Thymus fallax Fisch & C.A.Mey.	87.50 ± 6.89b	379.99 ± 4.84b	0.99 ± 0.30b
Thymus kotschyanus Boiss. & Hohen. subsp. *kotschyanus*	76.33 ± 0.86c	380.93 ± 5.89b	ND
Thymus migricus Klokov & Des.-Shost.	77.01 ± 0.51c	310.95 ± 6.95cd	1.12 ± 0.17b
Thymus praecox Opiz	62.06 ± 3.45d	243.49 ± 23.98f	1.00 ± 0.08b
Thymus transcaucasicus Ronniger	34.81 ± 0.54g	198.51 ± 5.47g	0.98 ± 0.09b
Ziziphora capitata L.	121.67 ± 1.20a	492.17 ± 28.33a	1.72 ± 0.13a
Ziziphora clinopodioides Lam.	76.96 ± 1.51c	313.85 ± 2.62c	0.71 ± 0.11c
LSD (0.05)**	4.83	28.68	0.21
CV	3.91	5.37	14.61

* The letters indicate differences ($P < 0.05$) between means

** The least significant difference

The highest concentration (2.88 g kg^{-1}) of sulfur was found in *M. spicata* (Table 3), comparable to that reported earlier by Özcan (2004). The sulfur levels for *Thymus* spp. were ranged 1.32 to 1.44 g kg^{-1} and were lower than *T. vulgaris* (1.54 g kg^{-1}) (Özcan 2004).

Calcium is an essential mineral for healthy bones, gums and teeth (Bhat et al. 2010), and muscle, and also nerve health depends on calcium (Lokhande et al. 2009). The herbal plants in this study are seen to be additional sources of calcium in herby cheese. The Ca contents of the selected plant species were significantly variable, however; *Z. capitata* had the highest calcium level (35.69 g kg^{-1}) and *T. transcaucasicus* was poorest in calcium (8.74 g kg^{-1}) (Table 3).

The manganese contents of the plant samples ranged from 34.81 to 121.67 mg kg^{-1} values, where the lowest mean value observed from *T. transcaucasicus* and the highest was obtained from *Z. capitata* (Table 4). These values are considerably higher than the content of many other plant species of West Africa (Glew et al. 2005) and eastern Anatolia (Turan et al. 2003), as previously reported.

The iron contents of analyzed plant species were in the range of 198.51–492.17 mg kg^{-1} (Table 4). The highest Fe content was screened from *Z. capitata* L., where the lowest observed from *T. transcaucasicus* (198.51 mg kg^{-1}). The Fe contents data of this study were higher than data (14.8–31.7 mg kg^{-1}) reported for some edible plants of West Africa (Glew et al. 2005) and (48.8 mg kg^{-1}) for

Table 5 Copper, cobalt, and zinc contents of wild edible plants in Eastern Anatolia, Turkey

Plant Names	Cu (mg kg^{-1})	Co (mg kg^{-1})	Zn (mg kg^{-1})
Mentha longifolia L.	14.12 ± 3.12d*	1.14 ± 0.00a	22.12 ± 1.18c
Mentha spicata L. subsp. *Spicata*	27.25 ± 0.88a	0.54 ± 0.20d	32.54 ± 1.67a
Ocimum basilicum L.	11.91 ± 1.66d	0.96 ± 0.10ab	17.60 ± 1.50ef
Thymus fallax Fisch & C.A.Mey.	24.53 ± 0.66a	0.89 ± 0.20abc	16.01 ± 0.09f
Thymus kotschyanus Boiss. & Hohen. subsp. *kotschyanus*	25.47 ± 1.33a	1.09 ± 0.00ab	26.53 ± 1.69b
Thymus migricus Klokov & Des.-Shost.	18.59 ± 3.10b	0.85 ± 0.10bc	27.81 ± 1.45b
Thymus praecox Opiz	25.27 ± 1.54a	1.00 ± 0.20ab	33.71 ± 1.21a
Thymus transcaucasicus Ronniger	15.09 ± 0.64cd	0.68 ± 0.10cd	20.00 ± 0.69d
Ziziphora capitata L.	18.17 ± 0.22bc	1.09 ± 0.30ab	18.77 ± 0.15de
Ziziphora clinopodioides Lam.	20.47 ± 2.61b	1.00 ± 0.20ab	20.35 ± 0.17cd
LSD (0.05)**	3.28	0.26	1.99
CV	9.52	16.60	4.93

* The letters indicate differences ($P < 0.05$) between means

** The least significant difference

Table 6 Dry matter, total ash, and nitrogen contents of wild edible plants in Eastern Anatolia, Turkey

Plant Names	Dry matter %	Total ash %	N %
Mentha longifolia L.	20.80 ± 0.43a*	11.00 ± 1.00bc	2.22 ± 0.05b
Mentha spicata L. subsp. *Spicata*	14.82 ± 0.27d	11.33 ± 1.15bc	2.42 ± 0.04c
Ocimum basilicum L.	13.73 ± 0.30e	13.67 ± 0.58a	2.60 ± 0.06a
Thymus fallax Fisch & C.A.Mey.	11.23 ± 0.10f	7.00 ± 1.00d	1.02 ± 0.02h
Thymus kotschyanus Boiss. & Hohen. subsp. *kotschyanus*	16.12 ± 0.21c	10.33 ± 0.58c	2.29 ± 0.03d
Thymus migricus Klokov & Des.-Shost.	18.62 ± 0.61b	7.00 ± 1.00d	1.10 ± 0.03g
Thymus praecox Opiz	16.07 ± 0.25c	7.00 ± 1.00d	1.41 ± 0.03f
Thymus transcaucasicus Ronniger	13.71 ± 0.51e	8.33 ± 0.58d	1.37 ± 0.03f
Ziziphora capitata L.	13.23 ± 0.88e	12.67 ± 1.15ab	1.36 ± 0.03f
Ziziphora clinopodioides Lam.	15.97 ± 0.61c	11.00 ± 1.00bc	2.15 ± 0.05e
LSD (0.05)**	0.83	1.67	0.05
CV	3.15	9.80	1.45

* The letters indicate differences ($P < 0.05$) between means

** The least significant difference

some edible plant species of eastern Anatolia (Turan et al. 2003).

The basic role of chromium as a trace metal nutrient is known to be in helping to maintain normal glucose tolerance in the body that is essential to humans and animals (Bhat et al. 2010). The chromium content was found to be relatively high in *Z. capitata* (1.72 mg kg^{-1}), but lower in *Z. clinopodioides* (0.71 mg kg^{-1}) (Table 4). Cr was not detected in *M. longifolia* or *M. spicata* in contrast to previously reported Cr concentrations in these two Mentha species (Özcan 2004). Also Cr was not detected in *T. kotschyanus*, in contrast to the other *Thymus* species in this study, which had around 1.0 mg kg^{-1}.

Copper is a vital constituent of many enzymes that catalyze oxidation–reduction reactions and is necessary for iron mobilization and collagen synthesis (Glew et al. 2005). As shown in Table 5, the highest copper level of herby cheese was found as 27.25 mg kg^{-1} in *Mentha spicata* L. subsp. *Spicata*, while the lowest in *Ocimum basilicum* L. as 11.91 mg kg^{-1}.

Cobalt was found in relatively low concentrations in all the analyzed species varying from 0.54 mg kg^{-1} (*M. spicata spicata*) to 1.14 mg kg^{-1} (*M. longifolia*) (Table 5). These values are considerably higher than the content (0.1–0.35 mg kg^{-1}) of many other plant species of plants that were reported by Rashed (2010).

Table 7 Crude protein, pH, and crude fiber contents of wild edible plants in Eastern Anatolia, Turkey

Plant Names	Crude protein	pH	Crude fiber
Mentha longifolia L.	13.86 ± 0.29b*	7.43 ± 0.1a	27.72 ± 0.32c
Mentha spicata L. subsp. *Spicata*	15.13 ± 0.23c	6.29 ± 0.0def	27.75 ± 0.55c
Ocimum basilicum L.	16.23 ± 0.36a	6.41 ± 0.2de	20.72 ± 0.45d
Thymus fallax Fisch & C.A.Mey.	6.37 ± 0.11h	6.69 ± 0.1c	43.13 ± 1.62a
Thymus kotschyanus Boiss. & Hohen. subsp. *kotschyanus*	14.34 ± 0.19d	6.79 ± 0.1bc	23.12 ± 0.86d
Thymus migricus Klokov & Des.-Shost.	6.85 ± 0.19g	6.2 ± 0.0ef	41.12 ± 0.68a
Thymus praecox Opiz	8.81 ± 0.16f	6.44 ± 0.1d	35.89 ± 0.59b
Thymus transcaucasicus Ronniger	8.56 ± 0.19f	6.19 ± 0.1f	35.94 ± 1.62b
Ziziphora capitata L.	8.52 ± 0.20f	7.22 ± 0.1a	42.41 ± 1.93a
Ziziphora clinopodioides Lam.	13.46 ± 0.31e	6.96 ± 0.2b	23.27 ± 4.00sd
LSD (0.05)**	0.44	0.22	2.94
CV	2.02	1.90	5.34

* The letters indicate differences ($P < 0.05$) between means

** The least significant difference

Table 5 shows that zinc content in *Thymus* spp. ranged from 16.01 mg kg^{-1} (*T. fallax*) to 33.71 mg kg^{-1} (*Thymus praecox*), higher than the zinc contents in *T. vulgaris* from Turkey (14.30 mg kg^{-1}) (Özcan 2004). The Zn level in *T. fallax* fell in the range observed (13.7–34.7 mg kg^{-1}) in previous studies of this plant (Özcan et al. 2008).

The dry matter contents of the analyzed plant species ranged between 11.23 and 20.80% (Table 6). *M. longifolia* had the highest value, while the lowest dry matter content was screened in *T. fallax* (11.23%). *M. longifolia* dry matter level that lies within the range recorded for *M. longifolia* from Pakistan revealed a seasonally dependent dry matter range of 19–47% (Ahmad et al. 2011).

The total ash values were found to be high in *O. basilicum* (13.67%) and low in *T. fallax, T. praecox,* and *T. migricus* (7.00%), which is consistent with the content of the other mineral elements (Table 6). The data of study are in good harmony with the results (ranged 6.67–15.33%) that were recorded by Tuncturk et al. (2015) on a number of other edible plant species from Anatolia.

The total nitrogen content of wild edible plants is of great interest. The highest level was found in *O. basilicum* (2.60%) and the lowest in *T. fallax* (1.02%) (Table 6). The highest content of nitrogen is higher than the maximum data reported by Turan et al. (2003) for *Rumex crispus* (1.70%).

Crude protein level can be evaluated as approximately equivalent to the total nitrogen content multiplied by a factor of 6.25. Total protein was the highest in *O. basilicum* (16.23%) and the lowest in *T. fallax* (6.37%) (Table 7). In comparison, Yıldırım et al. (2001) observed total protein contents of wild edible herbs from the Upper Çoruh Valley of Turkey to range from 3.50 to 6.75%.

The pH values of medicinal and comestible plants generally range from 5.2 to 6.6 (Tunctürk and Özgökçe 2015). In this work, the results of pH values varied from 6.19 (*T. transcaucasicus*) to 7.43 (*M. longifolia*) (Table 7).

As shown in Table 7, crude fiber contents of the analyzed plant species ranged from 20.72 to 43.13%. The highest crude fiber contents' value was obtained from *T. fallax* and the lowest value was in *O. basilicum*. In previous studies, the range of crude fiber contents of some other edible plants was reported between 19.38 and 43.9% (Tunctürk and Özgökçe 2015).

From this study, we conclude that observation of minerals and heavy metal concentrations in wild edible plants is highly important not only for their nutritional properties, but also to evaluate the quality when used in herby cheese. The results provide vital information on the mineral compositions for a few of the popular and nutraceutically valued plants of eastern Anatolia for herby cheese and for medicinal drugs, which need to be explored further to be used as food supplements and to exploit the potential health-promoting properties. Wild edible plants are important mineral sources (Turan et al. 2003) for herby cheese, indicating that they impart different taste, aroma, and nutritional value of Turkish traditional commercial herby cheese with different mixing ratios. Consumption of these products may become widespread as a source of minerals. These findings generally suggest that the use of these Lamiaceae species for the manufacturing of herby cheese will not cause heavy metal toxicity and may be beneficial to the users in cases of micronutrient deficiency (Kabata-Pendias and Pendias 2001; WHO 1996), where these metals were found to be present in the readily bioavailable form.

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