TÜBİTAK

Turkish Journal of Agriculture and Forestry

http://journals.tubitak.gov.tr/agriculture/

Research Article

Turk J Agric For
(2015) 39: 55-62

doi:10.3906/tar-1406-153

Chemical composition of some Apiaceae plants commonly used in herby cheese in Eastern Anatolia

Murat TUNÇTÜRK[1,*], Fevzi ÖZGÖKÇE[2]

[1]Department of Field Crops, Faculty of Agricultural, Yüzüncü Yıl University, Van, Turkey
[2]Department of Biology, Faculty of Science and Arts, Yüzüncü Yıl University, Van, Turkey

Received: 27.06.2014 • **Accepted:** 26.09.2014 • **Published Online:** 02.01.2015 • **Printed:** 30.01.2015

Abstract: Traditional uses of wild edible plants in daily diets are common in Eastern Anatolia. It is well known that more than 40 different plant species have been used as fresh vegetable, dried herbs, and pickled plants in some sole or mixed milk and meat products. The major use of wild edible plants is Van herby cheese in this region. To date, the mineral compositions of wild edible plants used in Van herby cheese production have been studied individually. In the present study, the plants were grouped by their plant families and their mineral compositions were determined. Therefore, variations and relations of minerals among the plants belonging to the same family were evaluated. The most used and well-known Apiaceae members such as *Anethum graveolens* L., *Anthriscus* sp., *Chaerophyllum macropodum*, *F. haussknechtii* H.Wolff ex Rech.f., *Ferula rigidula* DC., *Heracleum persicum*, *Hippomarathrum microcarpum*, *Pimpinella aurea* DC, and *Prangos ferulacea* L. were analyzed for their macro- and microelement concentrations (Ca, Co, Cu, Cr, Fe, K, Mn, Mg, N, Na, P, S, and Zn). Additionally, some food quality aspects (e.g., dry matter, total ash contents, crude protein contents, pH, and crude fiber contents) were also evaluated in the plant samples. In conclusion, plant samples analyzed had impressive diversity for mineral compositions and other properties. It can be concluded that these plentiful variations among plants belonging to the same family could have resulted from individual genetic structure, different growing conditions, and plants parts.

Key words: Apiaceae, food safety, mineral, quality, Van herby cheese

1. Introduction

Plants belonging to the family Apiaceae are extensively used for food and medicinal purposes. Some plants of this family such as carrots, parsley, and celery are common vegetable crops, while other members like anise, coriander, cumin, fennel, and dill are famous for their medicinal and aromatic properties. Different plant taxa of the family Apiaceae have been used as wild edible plants, besides these crop plants. To date, around 101 genera including 451 species under the family Apiaceae have been reported in Turkey (Özhatay et al., 2009). The plants of the family Apiaceae have been used for various purposes in different regions worldwide. For example, in Eastern Anatolia, Van herby cheese is a famous dairy product containing various plant species from this family. The plant taxa used in Van herby cheese production vary among regions according to the taste preference of people in the local communities. However, most of the plant taxa belong to the families Apiaceae, Lamiaceae, and Liliaceae (Özçelik, 1989).

Dairy products are the most important source of vitamins, minerals, and protein in the daily human diet. Their diversity and nutritional value vary with their ingredients and production process. Van herby cheese is a traditional dairy product produced on an industrial scale and marketed locally and internationally. It is distinctive from other dairy products in containing various aromatic and wild plants. It is thought that plants species used in this dairy product enrich its nutritional quality. There are a number of scientific reports claiming the useful mineral composition of aromatic and wild herbs (Turan et al., 2003; Özkutlu et al., 2006; Şekeroğlu et al., 2006, 2008). Besides mineral compositions, some nutritional properties such as dry matter, total ash contents, crude protein contents, pH, and crude fiber contents are also beneficial for human diets (Şekeroğlu et al., 2006).

Being an important source of minerals for humans, wild edible plants are consumed all over the world. It can be said that plants in the same families are usually used for similar purposes. Plants of the family Apiaceae have been used mainly for food purposes for a long time in human history. Therefore, in the present study, mineral compositions and nutritional values of some Apiaceae plant family members commonly used in Eastern Anatolia were investigated.

* Correspondence: murattuncturk@hotmail.com

2. Materials and methods

Nine wild edible plant species grown in Van district were analyzed for their mineral compositions and some nutritional properties. Plants used in this work were collected from Van Lake district in 2010 and botanically identified according to *Flora of Turkey* (Davis, 1972) described by the Department of Biology, Yüzüncü Yıl University. Plant characteristics are briefly illustrated in Table 1. Collected plants were washed with deionized water, dried at room temperature, and were ground before laboratory analysis. The samples were kept in plastic bags until analysis. Chemical analyses were performed on the herb parts used in cheese production.

For measuring the dry matter contents of the plant materials, the samples were dried at 105 °C for 24 h in an oven. Total ash content (inorganic matter) of the plant material was determined by an electric muffle furnace set at 550 °C. The Kjeldahl method and apparatus were used for determining total nitrogen contents of the samples, and crude protein contents were calculated. The pH of the samples was calculated by pH-meter. Crude fiber analyses were conducted according to the standard protocol of AOAC (AOAC, 2000: method 962.09, 2000). For mineral analysis, the plant samples were reduced to ashes in a furnace by nitric acid (AR) and hydrochloric acid (AOAC, 2000), and then distilled water (50 mL) was added to the samples in a volumetric flask. All the analysis was repeated 3 times to achieve accuracy. Mineral contents were determined by atomic absorption spectrometry. Average data were calculated by computer office programs and given with standard deviations.

3. Results and discussion

In the present study the chemical composition of some edible plants from the family Apiaceae commonly used in Eastern Anatolia were investigated. Average data obtained from laboratory analyses are given in Tables 2–4. The Na concentrations of the analyzed plant samples varied from 0.32 to 1.26 g kg^{-1} (Table 2). The highest Na concentration was found in dill samples, while the lowest value was found in *Pimpinella aurea* DC. samples. The magnesium levels of the plant samples ranged from 1.77 to 6.02 g kg^{-1}, with the highest and lowest mean values observed in *Heracleum persicum* Desf. and *Prangos ferulacea* (L.) Lindl., respectively. Potassium contents of the selected plant species were noticeably variable; *Heracleum persicum* Desf. had the highest potassium level, whereas *Pimpinella aurea* DC. roots were poor in potassium contents. The Ca concentrations of the analyzed plants ranged from 5.56 to 20.60 g kg^{-1}, with the highest and the lowest calcium levels measured in the stems of *Anthriscus nemorosa* (M.Bieb.) Spreng. and *Prangos ferulacea* (L.) Lindl. stems,

Table 1. Some traits of some *Apiaceae* plants used for Van herby cheese production.

Plants' scientific name	Local name	Parts used	Locality	Col. no.
Anethum graveolens L.	Dere otu	Leaf, stem	Grown	-
Anthriscus nemorosa (M.Bieb.) Spreng.	Hitik	Stem	L1	F 12306
Chaerophyllum macropodum Boiss.	Mendi	Stem	L2	F 11176
Ferula haussknechtii H.Wolff ex Rech.f.	Parzik	Stem	L3	F 14223
Ferula rigidula DC.	Siyabo	Stem	L4	F 12770
Heracleum persicum Desf.	Soh, Sov	Stem	L5	F 11177
Hippomarathrum microcarpum (M.Bieb.) Fedtsch.	Çakşır otu	Stem	L6	F 15901
Pimpinella aurea DC.	Giyahevin	Root *	L7	F 12314
Prangos ferulacea (L.) Lindl.	Heliz	Stem	L8	F 11175

* Used for preparation of animal coagulant
L1: B9 Bitlis, Tatvan, north slopes of Alacabük Mountain, Gençler avenue, 2100 m,
L2: B9 Bitlis, Tatvan, north slopes of Alacabük Mountain, Gençler avenue, 2100 m,
L3: B9 Van, Gürpınar Zernek dam between Çörekli village, stony steppe, 1980 m,
L4: B9 Bitlis, Tatvan, Alacabük Mountain, the upper part of Doluca village, 2000 m,
L5: B9 Bitlis, Tatvan, north of Alacabük Mountain, Gençler avenue, steppe, 2100 m,
L6: B9 Van, Gevaş, around Kazanç village, steppe, 2100 m,
L7: B9 Bitlis, Tatvan, Alacabük Mountain, Kesan brook, 10 km from highway, around Sallıca village, 1650–1750 m,
L8: B9 Bitlis, Tatvan, north of Alacabük Mountain, Gençler avenue, steppe, 2100 m.

Table 2. Macroelement concentrations of some analyzed plant species.

Plant names	Na (g/kg)	Mg (g/kg)	K (g/kg)	Ca (g/kg)	P (g/kg)	S (g/kg)
Anethum graveolens L.	1.26 ± 0.05	4.53 ± 0.15	27.4 ± 0.32	20.0 ± 1.21	4.31 ± 0.07	2.38 ± 0.15
Anthriscus nemorosa (M.Bieb.) Spreng.	0.68 ± 0.01	3.21 ± 0.03	20.7 ± 1.18	20.6 ± 1.43	2.5 ± 0.32	0.52 ± 0.12
Chaerophyllum macropodum	0.38 ± 0.05	2.88 ± 0.05	31.6 ± 0.47	16.4 ± 0.14	2.64 ± 0.21	0.41 ± 0.13
F. haussknechtii H.Wolff ex Rech.f.	0.54 ± 0.03	4.08 ± 0.15	13.8 ± 0.86	14.1 ± 0.82	2.51 ± 0.11	0.31 ± 0.05
Ferula rigidula DC.	0.51 ± 0.03	2.11 ± 0.06	25.6 ± 1.14	10.6 ± 0.42	3.72 ± 0.27	1.39 ± 0.06
Heracleum persicum	0.49 ± 0.02	6.02 ± 0.29	33.9 ± 0.82	18.2 ± 0.88	0.94 ± 0.03	0.25 ± 0.01
Hippomarathrum microcarpum	0.56 ± 0.01	5.39 ± 0.46	8.67 ± 1.09	16.7 ± 0.34	1.12 ± 0.02	1.29 ± 0.04
Pimpinella aurea DC	0.32 ± 0.02	1.99 ± 0.42	4.88 ± 0.12	6.78 ± 0.08	1.13 ± 0.05	1.17 ± 0.04
Prangos ferulacea (L.)	0.68 ± 0.01	1.77 ± 0.32	23.1 ± 1.61	5.56 ± 1.08	2.81 ± 0.2	1.26 ± 0.05

respectively. All the analyzed plants had considerable phosphorus contents, with the highest P level noted in dill herbage, whereas the plant samples of *Heracleum persicum* Desf. stems harbored the poorest P levels. The highest sulfur contents were found in dill herbage, and the lowest level was determined in *Anthriscus nemorosa* (M.Bieb.) Spreng. stems. Considering the macroelement concentrations of all analyzed plant species used in Van herby cheese, *Anthriscus nemorosa* (M.Bieb.) Spreng. had the highest levels. *Heracleum persicum* Desf., *Pimpinella aurea* DC., and *Prangos ferulacea* (L.) Lindl. had the lowest values of macroelement concentrations in the studied plant samples (Figures 1 and 2).

In previous studies related to mineral concentrations of medicinal plants and edible vegetables, the Na concentrations ranged from 0.21 to 63.32 g kg^{-1} (Holland et al., 1997; Demir, 2006; Koca et al., 2008, 2009; Akgünlü, 2012).

Magnesium is required for both plant development and human health (Özer et al., 2010). Akgünlü (2012) investigated the mineral compositions of some edible plants consumed in the southeastern part of Turkey. According to his results, the Mg levels of the analyzed plant samples varied from 24.57 (*Arum dioscorides* L.) to 86.43 g kg^{-1} (*Sinapis alba* L.). The Mg levels of the medicinal and edible plants were reported between 1.17 g kg^{-1} and 29.31 g kg^{-1} (Holland et al., 1997; Corlett et al., 2002; Turan et al., 2003; Karaköy et al., 2012). Among the macroelements, potassium has a special place in plant development and for human health. Akgünlü (2012) found that the highest macroelement in the studied wild vegetables was potassium. In the present study, potassium had the

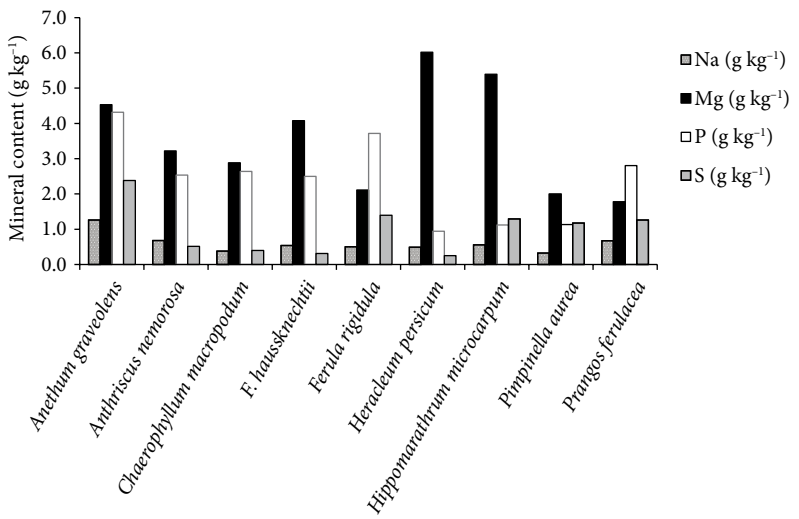

Figure 1. Na, Mg, P, and S concentrations of some plant species.

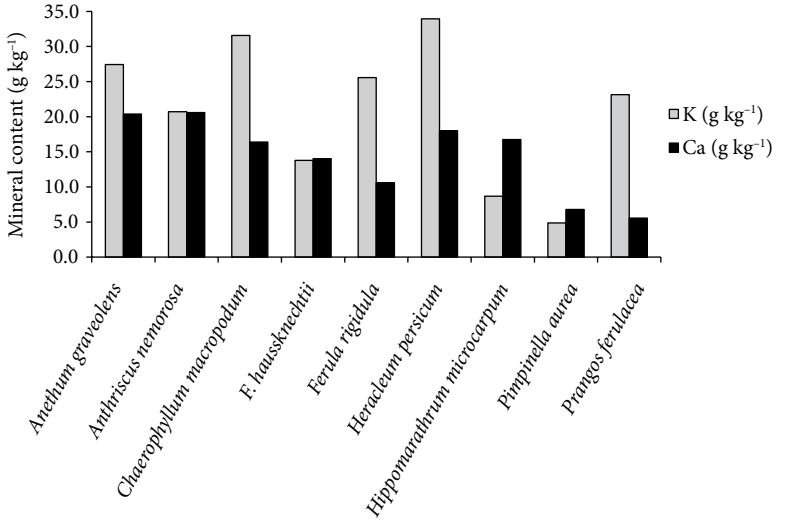

Figure 2. K and Ca concentrations of some plant species.

biggest portion among the determined macroelements. Potassium content changed from 245.78 to 557.91 g kg^{-1} in wild vegetables (Akgünlü, 2012). The Ca levels of the studied plant species were determined between 5.56 g kg^{-1} and 20.6 g kg^{-1}; the highest and lowest Ca contents were found in *Anthriscus nemorosa* (M.Bieb.) Spreng. and *Prangos ferulacea* (L.) Lindl., respectively. Calcium concentrations of some medicinal and edible plants were found in a wide range from 0.03 to 777.52 g kg^{-1} in previous studies (Şeker, 1992; Koca et al., 2008, 2009; Akgünlü, 2012). In these studies, it was found that nettle leaves (*Urtica dioica* L.), a well-known medicinal and wild vegetable plant all over the world, had the highest Ca levels. The highest and lowest phosphorus contents of the analyzed plant samples were determined in *Anethum graveolens* L. (4.31 g kg^{-1}) and *Heracleum persicum* Desf. (0.94 g kg^{-1}), respectively. Yorgancilar (2009) found a P content of 47.97 g kg^{-1} in *Lupinus albus* L. The P levels were determined between 69.13 (*Papaver rhoeas* L.) and 34.92 g kg^{-1} (*Mentha longifolia* L.) in some wild vegetables in Turkey (Akgünlü, 2012). The S content of some Apiaceae plant species used in Van herby cheese ranged from 0.25 g kg^{-1} to 2.38 g kg^{-1} (Table 1). According to average data, *Anethum graveolens* L. had the highest S content among the analyzed plant species and *Heracleum persicum* Desf. had the lowest value. Sulfur concentrations in some wild edible vegetables were found in the range of 39.37 g kg^{-1} (*Arum dioscorides*) and 108.01 g kg^{-1} (*Nasturium officinale* L.) (Akgünlü, 2012). Koca et al. (2008) reported that the S contents of *Gentiana olivieri*, whose roots are used for medicinal purposes, was 16.31 g kg^{-1}. *Arnebia densiflora* root cortex had 12.34 g kg^{-1} sulfur concentration (Koca et al., 2009). Considering previous studies on macroelement concentrations of some medicinal and wild edible plants, it was noted that our findings for some Apiaceae plant species are in harmony with the findings of the earlier researchers. It is well known that a number of factors such as plant species, soil characteristics, and water availability in the soil considerably affect the mineral composition of plants (Şekeroğlu, 2012; Baloch et al., 2014). In the present study, there was also a wide variation in macroelement contents among the studied plant species.

The ranges of trace element concentrations were ascertained in plant tissues and are collectively listed in Table 3. It was determined that each plant contains significant different values of elements (Figures 3 and 4). Manganese (Mn) contents fluctuated greatly in different plant species. Herein, it was found to vary between 17.1 mg kg^{-1} (*Chaerophyllum macropodum*) and 48.5 mg kg^{-1} (*Ferula haussknechtii* H.Wolff ex Rech.f.). In previous reports, levels of Mn were in the ranges of 5–58 mg kg^{-1} (Şekeroglu et al., 2008), 32.64–105.56 mg kg^{-1} (Jabeen et al., 2010), and 23–244 mg kg^{-1} (Başgel and Erdemoğlu, 2006). With respect to iron (Fe) levels, the mean Fe contents ranged from 81 mg kg^{-1} (*Prangos ferulacea* L.) to 324 mg kg^{-1} (*Pimpinella aurea* DC). Based on the report by Başgel and Erdemoğlu (2006), Fe concentration of herbs was in the range of 224–502.7 mg kg^{-1}. The general mean Cu contents varied between 3 and 8 mg kg^{-1} for leafy vegetables and 3.0 mg kg^{-1} for edible plants (Kabata-Pendias and Pendias, 2007). The concentration of Cu changed between 10.50 mg kg^{-1} (*Prangos ferulacea* L.) and 23.7 mg kg^{-1} (*Ferula haussknechtii* H.Wolff ex Rech.f.).

The zinc (Zn) contents ranged from 6.78 mg kg^{-1} (*Hippomarathrum microcarpum*) to 46.9 mg kg^{-1} (*Anethum graveolens* L.). In previous research, levels of Zn were in the range of 17.38–65.85 ppm in some medicinal plants and were 0.26–4.80 mg kg^{-1} in the study conducted by Başgel and Erdemoğlu (2006). Cr contents varied from 0.01 to 0.35 mg kg^{-1} (Kabata-Pendias and Pendias, 2007)

Table 3. Microelement concentrations of some plant species.

Plant names	Mn (mg/kg)	Fe (mg/kg)	Cu (mg/kg)	Zn (mg/kg)	Cr (mg/kg)	Co (mg/kg)
Anethum graveolens L.	47.9 ± 1.43	219 ± 3.89	22.2 ± 0.9	46.9 ± 1.72	nd	0.93 ± 0.17
Anthriscus nemorosa (M.Bieb.) Spreng.	29.5 ± 1.87	308 ± 10.9	16.2 ± 0.32	21.6 ± 2.01	0.97 ± 0.14	Nd
Chaerophyllum macropodum	17.1 ± 1.55	229 ± 5.21	12.6 ± 0.58	15.3 ± 0.77	0.35 ± 0.03	1.21 ± 0.04
F. haussknechtii	48.5 ± 2.33	240 ± 14.1	23.7 ± 3.34	13.1 ± 0.66	0.62 ± 0.06	0.53 ± 0.22
Ferula rigidula DC.	27.2 ± 2.63	149 ± 1.08	21.2 ± 1.14	36.6 ± 1.01	0.61 ± 0.05	0.71 ± 0.11
Heracleum persicum	22.4 ± 0.71	89 ± 4.48	16.1 ± 3.73	27.1 ± 0.21	0.35 ± 0.12	0.66 ± 0.09
Hippomarathrum microcarpum	29.3 ± 0.51	97 ± 3.21	12.5 ± 0.87	6.78 ± 0.61	nd	1.23 ± 0.24
Pimpinella aurea DC	29.2 ± 2.31	324 ± 5.31	12.1 ± 0.69	14.2 ± 3.04	0.66 ± 0.09	1.09 ± 0.06
Prangos ferulacea (L.)	21.9 ± 1.35	81 ± 6.67	10.5 ± 0.98	40.9 ± 0.52	nd	nd

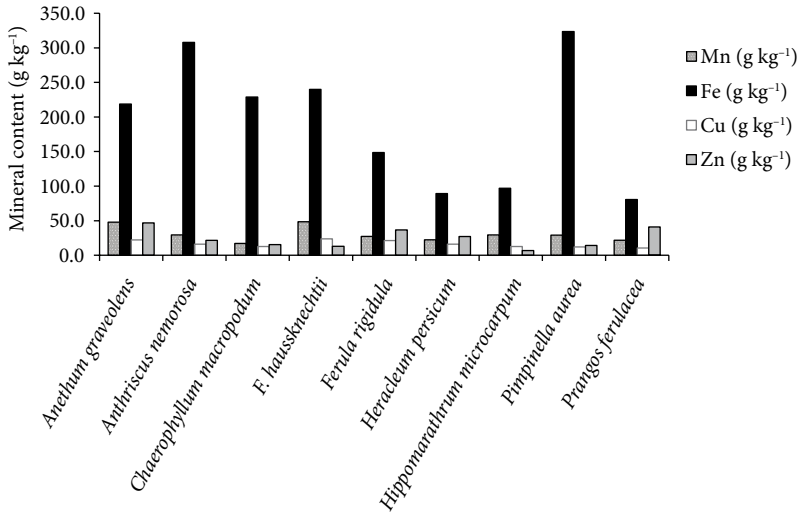

Figure 3. Mn, Fe, Cu, and Zn concentrations of plant species.

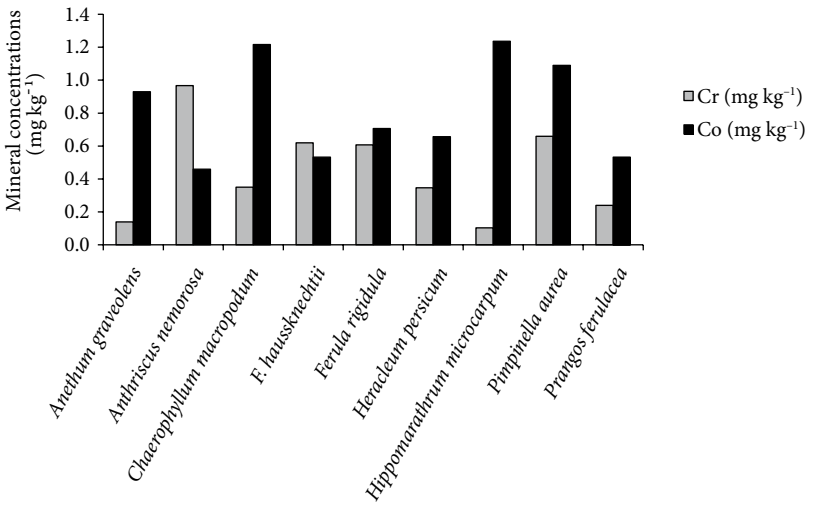

Figure 4. Cr and Co concentrations of plant species.

or from 0.07 mg kg^{-1} to 0.41 mg kg^{-1} (Bratakos et al., 2002), or the permissible levels (0.02 mg kg^{-1}), which have been established as the upper limit for safe human consumption recommended for medicinal plants (FAO/WHO, 1984). In the present study, however, Cr concentration varied between 0.35 mg kg^{-1} (*Chaerophyllum macropodum* and *Heracleum persicum*) and 0.97 mg kg^{-1} (*Anthriscus* sp.). In addition, Cr concentration was not detected in *Anethum graveolens* L., *Hippomarathrum microcarpum*, or *Prangos ferulacea* L. Cobalt (Co) content was not detected in *Anthriscus* sp. or *Prangos ferulacea* L. The Co contents ranged from 0.53 mg kg^{-1} (*Ferula haussknechtii* H.Wolff ex Rech.f.) to 1.23 mg kg^{-1} (*Hippomarathrum microcarpum*).

Dry matter content of the investigated plant species varied between 11.10% and 59.80% (Table 4). *Pimpinella aurea* DC. had the highest dry matter, while the lowest value was observed in *Hippomarathrum microcarpum*. Dry matter content depends on plant tissue structure; that is why this huge diversity is expected for different plant species. Analyzed plant materials had a wide range of total ash contents from 4.33% to 20.70%.

The highest total ash content was determined in *Heracleum persicum* and the lowest content was found in *Hippomarathrum microcarpum*. Total ash contents may be thought of as an indicator of total mineral contents in the plant materials. In this content, it could be inferred that *Heracleum persicum* was the richest plant by means of minerals among the analyzed plant species. Among the studied plant species, the highest total N and crude protein contents were noted in *Ferula rigidula* DC (Figure 5).

Hippomarathrum microcarpum had the lowest total N and crude protein levels. *Ferula haussknechtii* H.Wolff ex

Table 4. Some nutritional values of analyzed plant species.

Plant names	Dry matter (%)	Total ash(%	N (%)	Crude protein (%)	pH	Crude fiber(%)
Anethum graveolens L.	14.9 ± 0.63	15.7 ± 0.58	1.21 ± 0.06	7.47 ± 0.37	5.9 ± 0.1	33.4 ± 1.02
Anthriscus nemorosa (M.Bieb.) Spreng.	12.5 ± 0.54	7.10 ± 1.1	0.97 ± 0.04	6.03 ± 0.28	6.1 ± 0.1	43.9 ± 1.48
Chaerophyllum macropodum	20.7 ± 1.99	17.3 ± 1.15	0.91 ± 0.03	5.80 ± 0.12	6.0 ± 0.2	40.3 ± 0.99
F. haussknechtii H.Wolff ex Rech.f.	11.3 ± 0.41	6.66 ± 1.15	1.21 ± 0.04	7.61 ± 0.23	6.9 ± 0.1	37.1 ± 2.21
Ferula rigidula DC.	17.8 ± 0.96	11.3 ± 1.15	1.41 ± 0.05	8.85 ± 0.35	5.7 ± 0.2	27.5 ± 1.14
Heracleum persicum	16.2 ± 0.54	20.7 ± 1.52	1.35 ± 0.06	8.31 ± 0.25	5.4 ± 0.1	42.9 ± 0.73
Hippomarathrum microcarpum	11.1 ± 0.32	4.33 ± 0.57	0.82 ± 0.05	5.11 ± 0.31	5.6 ± 0.2	40.3 ± 1.04
Pimpinella aurea DC	59.8 ± 1.29	6.33 ± 0.57	0.96 ± 0.01	6.04 ± 0.09	6.3 ± 0.1	40.5 ± 1.25
Prangos ferulacea (L.)	16.5 ± 0.87	10.3 ± 0.57	1.34 ± 0.57	8.41 ± 0.46	6.3 ± 0.1	35.8 ± 0.63

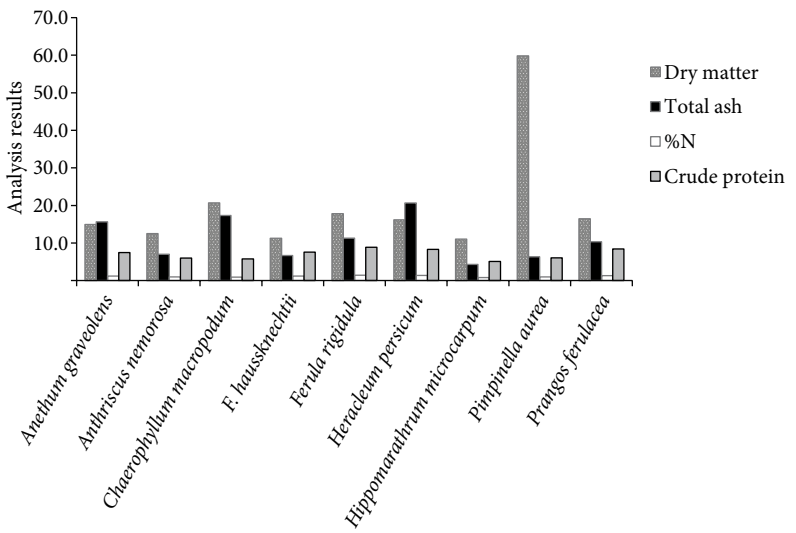

Figure 5. Dry matter, total ash, N, crude protein, pH, and crude fiber contents of plant species.

Rech.f. and *Heracleum persicum* had the highest and lowest pH levels in the analyzed plant species. The pH values of analyzed plant species were similar. Crude fiber contents of the analyzed plant samples ranged from 27.5% to 43.9%. The highest crude fiber contents were found in *Anthriscus nemorosa* (M.Bieb.) Spreng. and the lowest value was in *Ferula rigidula* DC. In previous studies, total ash content of edible plants was reported between 7.00% and 18.50% (Yıldırım et al., 2001; Şekeroğlu et al., 2006; Karaköy et al., 2013). Şekeroglu et al. (2006) studied nutritional values of some wild vegetables consumed in the Eastern Black Sea region of Turkey; they determined total ash contents of the plants between 4.00% and 23.00%, and the highest value was in *Ornithogalum umbellatum*. In another report, the highest total ash contents (26.70%) were found in *Urtica urens* L. by Turan et al. (2003). Total N contents of some medicinal and edible plants ranged from 0.20 to 1.70 in earlier studies. These reports also indicated that crude protein contents in edible plants were in the range of 1.30%–11.56% (Yıldırım et al., 2001; Turan et al., 2003; Şekeroglu et al., 2006; Özer et al., 2012).

4. Conclusions

Plants are a good source of useful chemicals such as minerals, vitamins, proteins, and fibers for human diets and animal feed. According to recent scientific papers, some plant families differ from others by their chemical characteristics. Similarly, wild plants grow in pure soils without sufficient water and produce much more specific chemicals. Turkey has a great deal of plant genetic diversity, and different plant families naturally grow in different parts of the country with various topographical, geographical, and climatic properties. Some common plant species with wide adaptation capabilities can be found in all regions. Although purposes of use of wild plants are mainly similar, some differentiations may occur due to local cultural preferences. Apiaceae plant family members naturally grow in almost all parts of Turkey. Their consumption as food is more or less similar in all regions of the country. In the present study, mineral compositions and nutritional values of some Apiaceae plant family members commonly used in Eastern Anatolia were investigated. Accordingly, macro- and microelement contents and nutritional value of the analyzed plants were similar and in harmony with previously reported data.

References

Akgünlü SB (2012). Mineral content and microbiological analysis of some wild edible vegetables consumed in Kilis and Gaziantep provinces. MSc, Kilis 7 Aralik University, Graduate School of Natural and Applied Sciences, Turkey.

AOAC (2000). Official method of analysis 962.09 (17th Edition) Volume I. Association of Official Analytical Chemists, Inc., Maryland, USA.

Baloch FS, Karaköy T, Demirbaş A, Toklu F, Özkan H, Hatipoğlu R (2014). Variation of some seed mineral contents in open pollinated faba bean (*Vicia faba* L.) landraces from Turkey. Turk J Agric For 38: 591–601.

Başgel S, Erdemoğlu SB (2006). Determination of mineral and trace elements in some medicinal herbs and their infusions consumed in Turkey. Sci Total Environ 359: 82–89.

Bratakos MS, Lazos ES, Bratakos SM (2002). Chromium content of selected Greek foods. Sci Total Environ 290: 47–58.

Corlett JL, Clegg MS, Keen CL, Grivetti LE (2002). Mineral content of culinary and medicinal plants cultivated by Hmong refugees living in Sacramento, California. Inter J Food Sci Nutr 53: 117–128.

Davis PH (1972). Flora of Turkey and the East Aegean Islands. Vol. 4, Edinburgh, UK: Edinburgh University Press.

Demir H (2006). Chemical composition of the some plants grown in Erzurum province. Univ Atatürk, J Fac Agric 35: 55–60.

FAO/WHO (1984). Food and Agriculture Organization/World Health Organization; Contaminants. In codex Alimentarius, Vol. XVII, Edition 1. Codex Alimentarius Commission, Rome.

Holland EA, Braswell BH, Lamarque JF, Townsend A, Sulzman J, Muller JF, Dentener F, Brasseur G, Levy HI, Penner JE, Roelofs GJ (1997). Variations in the predicted spatial distribution of atmospheric nitrogen deposition and their impact on carbon uptake by terrestrial ecosystems. J Geophys Res 102: 15,849–15,866.

Jabeen S, Shah MT, Khan S, Hayat MQ (2010). Determination of major and trace elements in ten important folk therapeutic plants of Haripur basin, Pakistan. J Medic Plants Res 4: 559–566.

Kabata-Pendias A, Pendias H (2001). Trace Elements in Soils and Plants, 3rd edition, Boca Raton, FL, USA: CRC Press.

Koca U, Şekeroğlu N, Özkutlu F (2008). Mineral composition of *Gentiana olivieri* Griseb. (*Gentianaceae*): a traditional remedy for diabetes in Turkey. Proceedings of Fifth Conference on Medicinal and Aromatic Plants of Southeast European Countries, 2–5 September 2008, pp. 139–140.

Koca U, Özkutlu F, Şekeroğlu N (2009). Mineral composition of *Arnebia densiflora* (Nordm.) Ledeb. an endemic medicinal plant from Turkey. Biomed 4: 51–56.

Karaköy T, Erdem H, Baloch FS, Toklu F, Eker S, Kilian B, Özkan H (2012). Diversity of macro- and micronutrients in the seeds of lentil landraces. The Scientific World J 2012: 1–9.

Karaköy T, Baloch FS, Toklu F, Özkan H (2013). Variation for selected morphological and quality-related traits among 178 faba bean landraces collected from Turkey. Plant Gen Res: Characterization and Utilization 12: 5–13.

Özçelik H (1989). An investigation on plants used in production of dairy products in Van province. Turk J Agric For 13: 356–360.

Özer S, Karaköy T, Toklu F, Baloch FS, Kilian B, Özkan H (2010). Nutritional and physicochemical variation in Turkish kabuli chickpea (*Cicer arietinum* L.) landraces. Euphytica 175: 237–249.

Özer S, Tümer E, Baloch FS, Karaköy T, Toklu F, Özkan H (2012). Variation for nutritional and cooking properties among Turkish field pea landraces. J of Food Agric Environ 10: 324–329.

Özhatay N, Akalın E, Özhatay E, Ünlü S (2009) Rare and endemic taxa of Apiaceae in Turkey and their conservation significance. J Fac Pharm İstanbul 40: 1–9.

Özkutlu F, Şekeroğlu N, Kara M (2006). Monitoring of cadmium and micronutrients in spices commonly consumed in Turkey. Res J Agric Bio Sci 2: 223–226.

Şeker T (1992). A study on the chemical composition of the natural edible mushroom growing in Samsun, MSc, University of Ondokuz Mayıs, Institute of Science.

Şekeroğlu N, Özkutlu F, Deveci M, Dede Ö, Yilmaz N (2006). Evaluation of some wild plants in terms of their nutritional values used as vegetable in Eastern Black Sea Region of Turkey. Asian J Plant Sci 5: 185–189.

Şekeroglu N, Özkutlu F, Kara ŞM, Özgüven M (2008). Determining of cadmium and micronutrients in medicinal plants from Turkey. J Sci Food Agric 88: 86–90.

Şekeroglu N, Meraler SA, Özkutlu F, Kulak M. 2012. Variation of mineral composition in different parts of mahaleb. Asian J Chem 24: 5824–5828.

Turan M, Kordali S, Zengin H, Dursun A, Sezen Y (2003). Macro and micro mineral content of some wild edible leaves consumed in Eastern Anatolia. Acta Agric Scand B-SP 53: 129–137.

Yıldırım E, Dursun A, Turan M (2001). Determination of the nutrition contents of the wild plants used as vegetables in upper Çoruh Valley. Turk J Bot 25: 367–371.

Yorgancılar M, 2009. Mineral content of debittered terma seeds (*Lunipus albus* L.). Selçuk Univ, J Agric Food Sci 23: 10–15.