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ORIGINAL PAPER

DETERMINATION OF THE NUTRITIONAL AND CHEMICAL COMPOSITION OF SOME EDIBLE WILD PLANTS USED IN HERBY CHEESE

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Abstract

Same as in many parts of the world, many edible weeds belonging to different families that have not been cultured in Turkey are traditionally used in the making of many foods. In this study, minerals and nutrients of six edible wild plant species belonging to the Liliaceae family, which are currently used in the production of herby cheese in the Eastern Anatolia region of Turkey, were determined. The determination of these macro- and micro-minerals was performed on ICP-AES and UV-Visible spectrophotometers. As a result of the study, major differences were discovered between these plant species in terms of the mineral content (Na, Mg, K, s, Ca, P, Fr, Mn, Cu, Zn, Cr, and Co) and nutrient properties (total ash, crude fibre, pH, N, and crude protein). Except for the *Allium schoenoprasum* species, all plant samples were found to be rich in many important minerals, such as Fe, Cu, Ca, K, Mn, and Zn, which are known to be vital for human health. The concentrations of these minerals and a few heavy metals in plant samples were found in the following ranges: 17.25 - 25.47 mg kg^{-1} for copper, 18.45 - 34.14 mg kg^{-1} for zinc, 33.42 - 98.42 mg kg^{-1} for manganese, 0.12 - 0.54 mg kg^{-1} for chromium, 0.31 - 1.61 mg kg^{-1} cobalt. Many significant correlations were found among the parameters analysed. The study presents essential results on the availability of some vital minerals that could be useful or harmful to consumers, in order to provide dietary information for designing value-added foods.

Keywords: Liliaceae, herby cheese, heavy metals, nutritional minerals.

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INTRODUCTION

Wild plants are acknowledged to be desirable resources of many nutrients, particularly in the diets of poor rural households. Some specific edible wild plants have played a significant role in most geographical areas in the world for different consumption purposes throughout the human history. As well as having nutritional value, such plants have been used as traditional medicine for curing some illnesses.

Turkey has a rich and diverse flora owing to a wide range of habitat types, including three phytogeographical regions (sea, lake and stream), as well as large differences in altitude (sea level – 5000 m), geological and geomorphological diversity, climate diversity (continental climate, ocean climate and the Mediterranean climate), and ecological differences between the east and the west of Anatolia, reflected in the floristic differences (Tunçtürk et al. 2017).

With its varied climate and different ecological zones, Anatolia has rich flora and abundant plant genetic resources. An example is the Liliaceae plants, a cosmopolitan family that is more prevalent in tropical and temperate regions. It is a big and important family of flowering plants, which includes important ornamental plants, aromatic plants and also vegetables and medicinal plants. This family is represented by 250 genera and 3500 species worldwide, and 35 genera and over 400 species in Turkey (Tanker et al. 2007).

In eastern Anatolia, edible wild plants have long been used as vegetables, herbal infusions, medicinal plants, etc. It is estimated that 25 plants belonging to six families, especially the Liliaceae, are consumed in dairy products in the region. These plants are used to give special aromas, flavours (Kavaz et al. 2013) and bio-preservative characteristics to herby cheese, which is a traditional, semi-hard salty Turkish cheese (Tarakci, Kucukoner 2008). Additionally, these plants are customarily essential as a dietary supplement, seen as a wellspring of vitamins and minerals.

In almost every corner of Anatolia, people cherish deep-rooted traditions that have grown through experience, after many painful and difficult experiments regarding the use of plants. These plants are sometimes used as dyestuffs in traditional handicrafts, sometimes to make medicines from plants, and sometimes they turn into food additives. The Anatolian people have been familiar with wild plants since ancient times, and they have always been benefiting from natural resources in various ways.

In many provinces of Eastern Anatolia, home-made herby cheese produced with these plants and consumed with pleasure is a local and original food (Figure 1). Especially, Van herby cheese, which is called "Van Otlu Peyniri" in Turkish, is a type of cheese obtained after a series of laborious processes, where it acquires original features depending on the raw material and pro-

Fig. 1. Cheeses made with different herbs

duction technique. Both the increase in sheep milk production in April, May and June, and the growth of the plants used in its production in the same months entail the production of herby cheese in the spring. Depending on the animal species kept on farms, sometimes this cheese is made by adding goat's milk to sheep's milk. However, in places close to city centers, herby cheese is made by adding herbs that are pickled in the spring in cow's milk. Raw or slightly heated milk is fermented at a temperature of about 30 degrees. The milk coagulates in 1-2 hours. Then, the coat of clot is removed and put in a cloth bag together with a layer of various herbs, previously chopped and prepared. When the bag is full, the mouth of the bag is closed and the bag is left to flatten by squeezing between two stones or by putting on a board with some weight on top (Coşkun, Öztürk 2000). Filtration takes 5-6 hours. The cheese is then cut into slices, approximately 2-3 cm thick. Coarse kitchen salt is spread on the slices, which are then left for 3-4 days. Afterwards, they are washed with plenty of saltwater. Layers of cheese are placed in earthenware vessels or plastic containers. One of the tricks is to put the cheese in a containers so that there is no space left between the cheese layers. After a container is filled, it is sealed with grape leaves and mud. Containers are then placed upside down in a cool place, completely covered with loose soil and left to ripen for 2 to 3 months before cheese is ready for consumption (Anonymous 2020). The amount of herbs added to cheese significantly affects the taste and aroma of the cheese as well as its quality. The species and quantity of plants used varies from region to region depending on preferences.

In the light of the above information, the aim of this present research was not only to study the basic nutrients and beneficial minerals but also to observe the trace metal content in selected edible wild plants grown in eastern Anatolia.

MATERIAL AND METHOD

Collection of samples

Six wild and edible herbal plants which might have been historically used in making Van herby cheese for flavour and aroma were collected from the plateaus of eastern Anatolia in 2012. The gathered plant samples were pressed and dried in line with herbarium techniques, and identified by the biologist Dr. Ozgokce with respect to the Flora of Turkey (Davis 1972); samples of vouchers were preserved in the Herbarium of Field Crops Department. The properties of these species are presented in Table 1.

Table 1

Some of the most valuable wild plants mixed to Van Herby Cheese

Plants	Family	Local name	Used parts	Col. No.
Allium akaka S.G. Gmelin	Liliaceae	Kuzukulağı	leaf	L1
Allium aucheri Boiss	Liliaceae	Sirmo, sirik, sirim	leaf	L6
Allium kharputense Freyn & Sint	Liliaceae	Saryoz, çorin	leaf	L3
Allium schoenoprasum L.	Liliaceae	Sirmo, sirik, sirim	leaf	L2
Allium vineale L.	Liliaceae	Sirmo, sirik, sirim	leaf	L4
Ornithogalum narbonense L.	Liliaceae	Altınyıldız	leaf	L5

L1: B9; Van Yuzuncu Yıl University, the meadows – steppes of Zeve village, 1700 m (altitude), F179;
L2: B9; Van, Gurpinar, Alpine meadows in the west-east of Koçguden village, 2850 m (altitude), M7337;
L3: B9; Van, Muradiye, permanent meadows of Topuzarpa village, 1720 m (altitude), M1192;
L4: B9; Van, Gurpinar, the meadows in north-west of Koçguden village, 2700 m (altitude), M7427;
L5: B9; Van, Ozalp, the middle of Dorutay, Aksorguç and Yumruklu villages, 2100 m (altitude), F1902;
L6: B9; Van, the northern slopes of Erek Mountain, altitude; 2550 m (altitude), MT026.

Sample preparation and treatment

The leaves of plants were cleansed manually from impurities. After that, the samples were washed both with running water and distilled water, and then they were dried at room temperature for evaporating any waste moisture. The leaf samples were ground in a laboratory stainless-steel mill. Ground samples were then stored in glass cups at 48°C until analysis.

Chemical analyses

The moisture content of samples was measured directly before analyses and then the material was dried for twenty-four hours, in an oven at 105°C, to determine the dry matter content. An electrical muffle furnace, set at 550°C, was used to determine the total ash content. The Kjeldahl equipment and methodology were employed to identify the content of nitrogen in the samples. Then, the crude protein ratio was calculated from the identified total nitrogen content, using an appropriate formula. The available hydrogen values (pH) were monitored with a pH-meter in the plant samples. Analyses of crude fibre were carried out according to AOAC (2000).

The amounts of sodium (Na), potassium (K), calcium (Ca), iron (Fe), magnesium (Mg), manganese (Mn), zinc (Zn), copper (Cu), cobalt (Co), chromium (Cr) in the milled samples were identified by Inductively Coupled Plasma - Atomic Emission Spectroscopy (ICP-AES) according to procedures of AOAC (2000). Phosphorus (P) and sulphur (S) were determined according to the molybdate-vanadate method on an UV-Visible Spectrophotometer. For quality testing, the mineral concentrations of samples were compared with the concentrations of known standard reference solutions, which were analysed at the same time.

Statistical analyses

Statistical analyses of all triplicate results obtained were carried out by using IBM SPSS Statistics v 22 based on the Anova procedures, and the results are given as mean ± SD (standard deviation) with the analysis of variance at a 5% significance level. The LSD (the least significant difference) multiple comparison test was used to evaluate statistically significant differences among the means at a 5% significance level. A correlation analysis was carried out to identify relationships among the observed parameters.

RESULTS AND DISCUSSION

The main nutrient and mineral concentrations of six Liliaceae species investigated are shown in Tables 2-4, including Sd, LSD and CV (Variation Coefficient) values. As can be seen in Tables 2-4, there were wide and significant (%5) variations among the observed parameters of the plant species.

Sodium enables the body to control the circulation of blood and the functions of muscles and nerves, but an excessive Na intake can damage the kidneys and increase the risk of high blood pressure. Therefore, the WHO recommends to reduce the intake by adults to < 2 g/day sodium (5 g/day salt). In the present study, as can be seen in Table 2, the amount of sodium ranges from 0.37 to 0.87 g kg^{-1}. The highest concentration of Na at 0.87 g kg^{-1} was determined in the *Allium aucheri Boiss* sample, whereas the *Allium schoenoprasum* sample had the lowest Na level (0.37 g kg^{-1}). These results lie within the ranges reported for a few different species of plant (0.32 to 1.26 g kg^{-1}) by Tunctürk and Özgökçe (2015).

Magnesium is a significant mineral in human nutrition. It participates in more than 300 enzymatic systems (Fox et al. 2001). It helps to ensure normal nerve and muscle function, promotes a healthy immune system, retains the steady heartbeat, (Joffres et al. 1987) and contributes to strong bones (Cohen 1988). The Mg concentrations in the samples ranged between

Table 2

Sodium, magnesium, potassium, sulphur, calcium and phosphorus content in plant samples

Plants	Na	Mg	K	S	Ca	P
	(g kg^{-1})	(g kg^{-1})	(g kg^{-1})	(g kg^{-1})	(g kg^{-1})	(g kg^{-1})
Allium akaka S.G. Gmelin	0.75±0.01*b*	2.15±0.08*d*	21.23±0.50*d*	1.33±0.12*b*	6.29±0.13*d*	3.66±0.19*a*
Allium aucheri Boiss	0.87±0.08*a*	3.63±0.21*b*	25.68±0.24*b*	1.39±0.03*ab*	11.08±0.21*b*	3.51±0.34*a*
Allium kharputense	0.84±0.02*a*	3.81±0.26*b*	23.17±0.61*c*	1.43±0.09*ab*	7.16±0.09*d*	2.48±0.22*b*
Allium schoenoprasum	0.37±0.01*d*	2.52±0.27*c*	25.16±0.73*b*	1.50±0.04*ab*	8.18±0.93*c*	2.60±0.08*b*
Allium vineale L.	0.72±0.00*b*	6.84±0.07*a*	11.65±1.48*e*	1.51±0.15*a*	8.74±0.88*c*	1.35±0.08*c*
Ornithogalum narbonense L.	0.56±0.01*c*	2.42±0.05*cd*	30.25±0.53*a*	1.35±0.05*ab*	17.03±0.24*a*	2.46±0.10*b*
CV (%)	4.890	5.030	3.560	6.990	5.140	3.930
LSD 0.05	0.060	0.330	1.480	0.180	0.910	0.190

Table 3

Iron, manganese, copper, zinc, chromium and cobalt concentrations in plant samples

Plants	Fe	Mn	Cu	Zn	Cr	Co
	(mg kg^{-1})	(mg kg^{-1})	(mg kg^{-1})	(mg kg^{-1})	(mg kg^{-1})	(mg kg^{-1})
Allium akaka S.G. Gmelin	251.53±8.58*cd*	55.13±0.11*d*	18.05±1.56*c*	24.06±0.84*b*	0.54±0.12*a*	1.01±0.31*b*
Allium aucheri Boiss	266.73±9.90*bc*	42.32±0.22*e*	20.10±0.22*b*	18.45±0.52*d*	0.12±0.04*b*	0.52±0.18*c*
Allium kharputense	274.02±8.80*bc*	84.55±4.29*b*	25.47±0.78*a*	34.14±1.91*a*	0.20±0.02*b*	1.41±0.15*a*
Allium schoenoprasum	247.56±3.93*d*	59.56±4.44*c*	13.07±0.18*d*	20.17±0.83*c*	nd	0.31±0.15*c*
Allium vineale L.	284.35±8.67*bc*	98.42±0.92*a*	17.59±1.02*c*	17.12±0.27*d*	0.17±0.05*b*	1.61±0.25*a*
Ornithogalum narbonense L.	451.53±12.12*a*	33.42±0.88*f*	18.41±0.57*c*	23.61±0.68*b*	0.18±0.05*b*	0.64±0.08*bc*
CV (%)	3.320	3.760	4.670	3.540	27.500	22.770
LSD 0.05	17.870	4.260	1.600	1.480	0.100	0.380

2.15 to 6.84 g kg^{-1} (Table 2). The maximum level was determined for *Allium vineale* L. and the minimum appeared in *Allium akaka* S.G. Gmelin.

Potassium is an essential mineral in the body, significant to both cellular and electrical functions (ELSON 2011). It participates in some enzymes as an activator and is vital for muscle functions and normal growth

Table 4

Total ash, nitrogen, crude protein, pH and crude fibre content in plant samples

Plants	Total ash (%)	Crude fibre (%)	pH	Nitrogen (%)	Crude protein (%)
Allium akaka S.G. Gmelin	8.33±0.58*b*	14.16±0.33*d*	4.90±0.11*e*	1.66±0.12*a*	10.35±0.73*a*
Allium aucheri Boiss	12.33±0.58*a*	18.59±0.55*c*	6.77±0.07*a*	1.31±0.06*bc*	8.20±0.38*bc*
Allium kharputense	12.67±1.15*a*	24.14±0.94*b*	6.04±0.08*bc*	1.71±0.04*a*	10.60±0.23*a*
Allium schoenoprasum	8.67±1.15*b*	24.26±1.01*b*	6.08±0.14*bc*	1.41±0.04*bc*	8.79±0.26*bc*
Allium vineale L.	9.00±1.73*b*	27.63±1.74*a*	5.71±0.18*d*	1.34±0.03*bc*	8.37±0.16*bc*
Ornithogalum narbonense L.	12.70±1.15*a*	18.25±1.05*c*	5.89±0.07*c*	1.28±0.07*c*	8.00±0.45*c*
CV (%)	4.100	5.210	1.560	3.990	4.010
LSD 0.05	0.790	2.010	0.170	0.110	0.660

(Lokhande et al. 2009). Potassium is found in a wide range of plant species. As seen in Table 3, *Ornithogalum narbonense* L. was the richest in potassium (30.25 g kg^{-1}), while *A. vineale* L. has the lowest potassium content (1.65 g kg^{-1}). The concentration of P in *O. narbonense* L. is higher than in some other plant species used in herby cheese that had been reported previously by Özcan et al. (2008) and Özcan (2004).

Sulphur is an element of the earth vital to the human health. It plays an essential role in many biological processes, including metabolism (Niknamian, Niknamian 2016). Thus, sulphur is an essential nutrient, but it cannot be synthesised by organs of the body and therefore must be acquired from a diet (Donohue 2014). The highest content (1.51 g kg^{-1}) of sulphur was found in *A. vineale* L., and the lowest content was obtained from *A. akaka* S.G. Gmelin as 1.33 g kg^{-1} (Table 3). The study results agree with the results concerning some other species and reported earlier by Özcan (2004).

Calcium is essential for the body's overall nutrition and health. It is a vital mineral for strong healthy bones, teeth and gums (Bhat et al. 2010); also, the health of muscles and nerves depends on calcium (Lokhande et al. 2009). Considering the importance of calcium, concentrations of this element in the plant species submitted to this styudt were analysed. As seen in Table 2, the Ca concentrations were observed to be on similarly high levels in all the analysed plant species, varying from 6.29 to 17.03 g kg^{-1}. The Ca concentrations in these plant species varied significantly, although *O. narbonense* L. had the highest calcium level and *A. akaka* S.G. Gmelin was the poorest in calcium. Similar results (6.6 - 18.1 g kg^{-1}) were reported by Zurawik et al. (2013) for *Allium tuberosum* rottler ex sprengal.

Phosphorus plays a critical role in the formation of bones and teeth, mineral metabolism, energy-transfer mechanisms and in various cellular functions covering intermediary metabolism (TAKEDA et al. 2004). The six edible wild plants were analysed to determine their content of phosphorus. As seen in Table 2, all the analysed samples had notable P content, where *A. akaka* S.G. Gmelin showed the highest P concentration (3.66 g kg^{-1}) and *A. vineale* L. had the lowest one (1.35 g kg^{-1}). These results, except *A. vineale* L., coincide with the results obtained for some other plant species (2.29-4.55 g kg^{-1}) reported by ÖZCAN et al. (2008), while being higher than the ones determined by KOLOTA et al. (2012) in *Allium fistulosum* L.

Iron is a significant element for blood production. It is needed for the formation of haemoglobin, which is responsible for the transfer of oxygen from lungs to all cells of the body. One of the Fe sources are dark green leafy edible plants. Therefore, the content of the Fe in leaves of plant species is important for good nutrition. According to the research results compiled in Table 3, iron concentrations of the species show significant variation, ranging from 247.56 to 451.53 mg kg^{-1}. The highest Fe concentration was determined in *O. narbonense* L., and the lowest level appeared in *Allium schoenoprasum*. These Fe values are higher than values (48.8 mg kg^{-1}) identified in some other wild plant species in eastern Anatolia and reported by TURAN et al. (2003). However, ZURAWIK and ZURAWIK (2015) reported that another *Allium* species, namely *Allium tuberosum* rottler ex sprengel, had an Fe content of dry matter 136.2 g kg^{-1}. According to the results of our study, the analysed herbal plants are a good source of Fe.

Manganese is a micro-mineral present in very small amounts in the body. It assists the formation of connective tissue, blood clotting factors, bones and sex hormones. Additionally, it also plays a significant role in carbohydrate and fat metabolism, absorption of calcium, regulation of blood sugar, normal functions of nerves and the brain. (EHRLICH, 2013). Table 3 shows that Mn concentrations of the samples vary between 33.42 to 98.42 mg kg^{-1}. The lowest average value was determined in *O. narbonense* L. while the highest one was detected in *A. vineale* L. These concentrations are notably higher than in *Allium cepa* L. species (GALDON et al. 2008) and higher than those previously reported by HACISEFEROĞULLARI et al. (2005).

Copper is a mineral that is necessary for the survival of the body. It assists the body in the production of red blood cells, and helps to maintain the healthy nerve cells and immune system (EHRLICH 2013). It is also an essential component of numerous enzymes, which catalyse oxidation and reduction reactions, in addition to which it is necessary for mobilisation of iron and the synthesis of collagen (GLEW et al. 2005). As it can be seen from data in Table 3, the highest Cu concentration among all the samples was determined in *Allium kharputense* (25.47 mg kg^{-1}), while the lowest one was in *A. schoenoprasum* (13.07 mg kg^{-1}). The copper content determined in *A. kharputense* was somewhat higher than that in *Allium roseum* (11.00 mg kg^{-1}) – NAJJAA et al. (2012).

Zinc, which is a vital trace mineral, is the most widespread element in the body, found in all cells. It has been used since ancient times to support wound healing, and it plays a significant role in the immune system, reproduction, growth, taste, blood clotting, smell, thyroid functions and proper insulin levels (EHRLICH 2013). Data in Table 3 show that Zn concentrations in the analysed plant species varied from 17.12 mg kg^{-1} (*A. vineale* L.) to 34.14 mg kg^{-1} (*A. kharputense*). These results are similar to but higher than concentrations determined in *A. roseum* (18.00 mg kg^{-1}) and *Allium sativum* L. (27.42 mg kg^{-1}) as reported by NAJJAA et al. (2012) and HACISEFEROĞULLARI et al. (2005), respectively.

Chromium is a trace element known to help maintain normal glucose tolerance in the body, which is essential for people and animals (BHAT et al. 2010, EHRLICH 2013). The Cr concentration was found to be high in *A. akaka* S.G. Gmelin (0.54 mg kg^{-1}) while the element was not detected in *A. schoenoprasum* and *A. vineale* L. (Table 3). The results of this research are in accordance with the Cr content in *A. roseum* previously reported by NAJJAA et al. (2012), but lower than Cr concentrations in *A. sativum* L. (HACISEFEROĞULLARI et al. 2005).

Cobalt is a vital element in humans, necessary for the formation of vitamin B_{12} (hydroxocobalamin), which catalyses reactions (BARCELOUX, BARCELOUX 1999). Co was determined at low levels in all analysed plant samples, ranging from 1.01 mg kg^{-1} (*A. akaka* S.G. Gmelin) to 1.61mg kg^{-1} (*A. vineale* L.) – Table 3. These results are notably higher than the concentration (0.28 mg kg^{-1}) determined in *A. sativum* L. (HACISEFEROĞULLARI et al. 2005).

Quantitation of total ash, crude fibre, pH, nitrogen and crude protein

The high ash content in the plant species was measured. The ash content in the samples ranged from 8.33% to 12.67% (Table 4), and depended on the high dry matter amount (BREWSTER 2008, NAJJAA et al. 2012). The highest total ash ratios were found in *A. kharputense* (12.70%) and *O. narbonense* L. (12.67%), with no statistically significant (0.05%) difference relative to *A. aucheri* Boiss (12.33%), while the lowest ratio was observed in *A. akaka* S.G. Gmelin. The data of this study lie within the range (6.67 to 15.33 %) of the results that were recorded by TUNCTURK et al. (2015) in a study on some other edible wild plant species in Anatolia, but higher than achieved from samples of *A. sativum* L. (2.30%) previously reported by HACISEFEROĞULLARI et al. (2005).

As shown in Table 4, crude fibre amounts in the analysed samples range from 14.16% to 27.63%. While the highest value of crude fibre was obtained in *A. vineale* L., the lowest one occurred in *A. akaka* S.G. Gmelin. The current results are notably higher than the crude fibre content of some other edible plants reported by HACISEFEROĞULLARI et al. (2005), e.g. 2.17% in *A. sativum.*

In this study, the results of pH are found in a range of 4.90 (*A. akaka* S.G. Gmelin) to 6.77 (*A. aucheri* Boiss) – Table 4. The determined pH values agree with the results determined by Haciseferoğullari et al. (2005) in *A. sativum* (6.05).

The total nitrogen amounts in the analysed samples varied at a 0.05% significance level, and the results ranged from 1.28% to 1.71% (Table 4). While the highest N amount was observed in *A. kharputense*, the lowest one was found in *O. narbonense* L. (Table 4). The highest content agreed with the data reported by Turan et al. (2003) for *Rumex crispus* (1.70%).

Crude protein as indicated in Table 4, the crude protein was the highest in *A. kharputense* (10.66%), without any statistically significant difference relative to *A. akaka* S.G. Gmelin (10.35%), while the lowest one was in *O. narbonense* L. (8.00%) (Table 4). These results were higher than the data reported by Haciseferoğullari et al. (2005) as determined in *A. sativum* (9.26) or the results determined by Yildirim et al. (2001) in some other edible wild plants (3.50% to 6.75%).

The relationships among the observed characteristics

A statistical analysis of correlations among all the observed parameters was performed to explore the relationships between pairs of observed parameters. Significant (P<1% and *P*<5%) correlations were determined (Table 5) due to the common and complicated metal interactions occurring in soil, water and plants (Galdon et al. 2008). Na presented significant positive correlations with the Cu (*r*=0.772), Cr (*r*=0.408) and Co (*r*=0.477) amounts. The Mg content correlated negatively with the concentrations of K (*r*=-0.809) and P (*r*=-0.716) but positively with S (*r*=0.455), Co (*r*=0.673) and crude fibre (*r*=0.715) – Table 5. K had significant positive correlations with Ca (*r*=0.559), P (*r*=0.515), Fe (*r*=0.467) and total ash (*r*=0.495) while having significant negative correlations with S (*r*=-0.433), Mn (*r*=-0.837), Co (*r*=-0.716) and crude fibre (*r*=-0.518) – Table 5. As can be seen in Table 5, the Ca content presented significant negative correlations with Mn (*r*=-0.604), N (*r*=-0.684) and crude protein (*r*=-0.681), but showed significant positive correlations with Fe and total ash amount. The P concentration show significant negative correlations with S (*r*=-0.487), Mn (*r*=-0.652), (*r*=-0.470) and crude fibre (*r*=-0.820) content, but it positively correlated with Cr (*r*=0.415). Data in Table 5 show that the S content had significant positive correlations with Mn (*r*=0.491) and crude fibre (*r*=0.678), but it had significant negative correlation with Cr (*r*=-0.564). A significant negative correlation was observed between Mn and Fe content (*r*=-0.450), while significant positive correlations were determined between Mn and Co (*r*=0.755) and crude fibre (*r*=0.756) amounts. The Fe content had a significant positive correlation with total ash (*r*=0.473), but it significantly negatively correlated with N (*r*=-0.452) and crude protein (*r*=-0.452). The Cu concentration was significantly correlated with Zn (*r*=0.714), Co (*r*=0.460), total ash (*r*=0.602), N (*r*=0.464) and crude protein (*r*=0.463) content. As can be seen from Table 5, Zn had significant positive correlations with N and crude fibre (*r*=0.741). The Cr content pre-

Table 5

Correlation table for the observed parameters of samples

Specification	Mg	K	Ca	P	S	Mn	Fe	Cu	Zn	Cr	Co	T.Ash	N	Cp	Ph	Cf
Na	0.323	-0.255	-0.206	0.237	-0.218	0.204	-0.206	0.772**	0.264	0.408*	0.477*	0.345	0.298	0.297	0.087	-0.183
Mg	1	-0.809**	-0.157	-0.716**	0.455*	0.777**	-0.161	0.142	-0.290	-0.203	0.673**	-0.10	-0.202	-0.200	0.126	0.715**
K		1	0.559**	0.515*	-0.433*	-0.837**	0.467*	0.023	0.276	-0.179	-0.716**	0.495*	-0.116	-0.118	0.348	-0.518*
Ca			1	-0.11	-0.182	-0.604**	0.908**	-0.062	-0.19	-0.305	-0.355	0.516*	-0.684**	-0.681**	0.327	-0.188
P				1	-0.487*	-0.652**	-0.238	0.068	0.130	0.415*	-0.470*	0.003	0.307	0.306	-0.026	-0.820*
S					1	0.491*	-0.259	-0.076	-0.17	-0.564**	0.154	-0.293	-0.167	-0.167	0.096	0.678**
Mn						1	-0.450	0.215	0.141	-0.026	0.775**	-0.287	0.337	0.338	-0.190	0.756**
Fe							1	0.049	0.062	-0.080	-0.103	0.473*	-0.452*	-0.447*	0.034	-0.177
Cu								1	0.714**	0.165	0.460*	0.602**	0.464*	0.463*	0.152	-0.019
Zn									1	0.252	0.293	0.357	0.741**	0.721**	-0.156	-0.080
Cr										1	0.363	-0.245	0.538*	0.536*	-0.764**	-0.620**
Co											1	-0.109	0.368	0.369	-0.375	0.399
Total ash												1	-0.156	-0.157	0.583**	-0.098
N													1	-0.421*	-0.447*	-0.136
Crude protein (Cp)														1	-0.448*	-0.136
Ph															1	0.277
Crude fibre (Cf)																1

* Correlation is significant at the 0.05 level, ** Correlation is significant at the 0.01 level

sented significant positive correlation with N and crude protein (r=0.538), but significant negative correlations with pH (r=-0.764) and crude fibre (r=-0.620) amounts. The total ash content had significant positive correlation with pH (r=0.583). The N content naturally presented significant positive correlation with crude protein (r=1.000), but it had a significant negative correlation with pH (r=-0.447). The amount of crude protein was affected significantly negatively by pH (r=-0.448). The correlation analysis shows that variations in the genetic information of leaves might cause variation in the mineral and heavy metal compositions.

CONCLUSION

The present study provides a new perspective on the presence of minerals and heavy metal concentrations as well as their nutritional properties in some local (Eastern Anatolia-Turkey) edible wild plants. These edible wild plants can become a source of minerals to meet the body's demand for minerals. The results of the study show that the use of these Liliaceae species in the production of herby cheese, but also of medicines, will not cause heavy metal toxicity. It was also concluded that the consumption of these plants will be beneficial to consumers in the case of micronutrient deficiencies.

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