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Nutritional Properties of some Wild Edible Plant Species in Turkey

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ABSTRACT: *Wild edible plants play an important role in daily diet of Turkish people. They have been used for food and also for medicinal purposes. Turkey is one of the important countries with its rich biodiversity in wild edibles and consists of more than 11.000 plant species. Most of the wild edible species can potentially make a considerable contribution to dietary requirements, so nutrient properties of these species should be determined to demonstrate the nutritional value of agricultural biodiversity. In this study some wild edible species from three different biogeographic regions of the Aegean, Black Sea and Mediterranean were collected and analyzed to demonstrate the nutritional value of some wild edibles in Turkey. Proximates, dietary fiber (DF), minerals and vitamin C were assayed using standard methods and reference materials. The findings of this study show that most of the wild edible species can considerably contribute to requirements of dietary fiber, vitamin C and some minerals such as iron, potassium and phosphorus. These species could be a good alternative to other commonly consumed plants due to their high nutrient content. However, preparation methods and consumption ways are also important in the evaluation of their contribution to dietary requirements.*

Keywords: *Biodiversity, wild edibles, nutrient composition.*

Bazı Yabani Yenilebilir Bitki Türlerinin Besin Özellikleri

ÖZ: *Yenilebilir yabani bitkiler, Türk halkının günlük beslenmesinde önemli bir rol oynamaktadır. Gıda olarak ve tıbbi amaçlar için kullanılmaktadır. Türkiye yenilebilir yabani türler açısından zengin bir biyoçeşitliliğe sahiptir ve 11.000'den fazla bitki türü barındırmaktadır. Yenilebilir yabani bitkiler günlük beslenme gereksinimlerinin karşılanmasında önemli bir yere sahiptir ve tarımsal biyoçeşitliliğin besin değerinin ortaya konulabilmesi için bu türlerin besin ögesi kompozisyonlarının belirlenmesi önem arz etmektedir. Çalışmada Ege, Karadeniz ve Akdeniz olmak üzere üç farklı biyocoğrafik bölgeden 12 farklı yenilebilir yabani bitki türü toplanarak besin ögesi kompozisyonunu belirlemek amacıyla analizler yapılmıştır. Standart yöntemler ve referans materyaller kullanılarak makro besin öğesi, mineral ve C vitamini analizleri gerçekleştirilmiştir. Çalışmanın bulguları, yenilebilir yabani bitkilerin çoğunun diyet lifi, C vitamini, demir, potasyum ve fosfor gibi bazı besin ögeleri açısından beslenmemize önemli ölçüde katkıda bulunduğunu göstermektedir. Bu bitkiler, yüksek besin içeriğinden dolayı yaygın olarak tüketilen diğer bitkilere alternatif olarak tüketilebilirler. Bununla birlikte, hazırlama yöntemleri ve tüketim şekli de beslenme gereksinimlerine olan katkının değerlendirilmesinde göz önünde bulundurulmalıdır.*

Anahtar Sözcükler: *Biyolojik çeşitlilik, yenilebilir yabani bitkiler, besin kompozisyonu.*

INTRODUCTION

Turkey contains a unique biological diversity with over 11.707 plant species recorded, of which 3.649 are endemic, including many nutritionally-important species (Guner *et al*., 2012). There are three different biogeographic regions in Turkey; Euro-Siberian, Irano-Turanian and the Mediterranean region each with its own endemic species and natural ecosystems.

Wild species are very important for global nutrition and food security (Hunter *et al.,* 2016; Toledo and Burlingame, 2006). Nutrient data for wild foods and cultivars should be systematically generated to help improve dietary diversity and to overcome hunger (Anonymous, 2008; Stadlmayr *et al*., 2011). However, to date there has been few studies on the food composition data of wild edible species in Turkey and also in other countries. This may be due to the low interest of researchers on the food composition data of wild species yet the nutritional value of wild species is very important for food security and nutrition to evaluate their contribution to nutrition and health (Burlingame *et al*., 2009).

Wild edible plants have an important role in Turkish cultural life. For many generations, they have been used as food, medicines, dyes and ornamentals and are also important source of income for local people in different regions. There are various ethnobotanical references from Turkey which emphasizes that wild plants have different uses in various parts of the country (Ozbucak *et al.* 2006; Altundag and Ozhatay, 2009; Ozhatay *et al*., 2009; Yucel *et al.,* 2010; Dogan *et al*., 2013; Polat *et al*., 2013;) They can be eaten raw or cooked and they constitute ingredients for many food dishes. They are mostly used by mixing with cultivated vegetables in the preparation of dishes. These wild plant species have great potential for contributing to improved incomes of local people. Most of these plants are collected for family consumption and for selling in local markets (Yildirim *et al.,* 2001; Sekeroglu *et al.,* 2006; Tan *et al*., 2011).

Although wild vegetables and fruits constitute an important part of the local population's diet, biodiversity in the three biogeographic regions is under threat from land and ecosystem degradation from urbanization, industrialization, fires, seasonal settlements and tourism among other threats (Karagoz *et al.,* 2016; Sekercioglu, *et al*., 2011). Additionally there is a lack of information about the nutritional characteristics of many wild edible species which contributes to poor awareness and understanding of the value of this local biodiversity. There have been some studies on the nutrient composition of wild edible plant species but none of these studies are comprehensive including proximate, mineral and vitamin content of these wild species (Ozbucak *et al*., 2007; Civelek *et al*., 2013).

The main aim of this study was to determine the nutrient content of some wild edible plants collected from the Black Sea, Aegean and Mediterranean Region of Turkey. This data will be helpful in promoting local species and varieties for dietary diversity and income generation, and also value and maintain the ecosystems that nurture them.

MATERIALS AND METHODS

Collection and preparation of samples

Ornithogalum umbellatum L., *Capsella bursa-pastoris* (L.) Medik., *Polygonum cognatum* Meissn., *Smilax excelsa* L., *Beta maritima* L., *Glebionis coronaria* (L.) Spach, Syn: *Chrysanthemum segetum* L., *Smyrnium olusatrum* L., *Cichorium intybus* L., *Dioscorea communis* (L.) Caddick&Wilkin, *Tragopogon porrifolius* subsp. *Longirostris* (Sch. Bip.) Greuter, *Eremurus spectabilis* M.Bieb., *Chondrilla juncea* L. species were prioritized for nutrition composition analysis. Samples were collected at the optimum time for harvesting during 2014 from Black Sea, Aegean and Mediterranean Regions. Taxonomic identification of the species were made according to "Flora of Turkey' (Davis, 1965-1985; Davis *et al.*, 1988).

Three batches of each species (about 200 g) were collected from three different sites to obtain representative data. One composite sample was prepared from three batches for each site. The weights of the each composite sample were approximately 600 g. The plant samples were transported at refrigerated temperature using cold packs to the laboratory on the same day of collection in order to protect nutrient composition of samples.

For sample preparation, the inedible parts of plants were removed and the edible parts were rinsed with tap water for 1-2 min and then with distilled water for 1 min. After cleaning, the plant samples were homogenized and subsamples were prepared for analysis. The subsamples were frozen at -20 ^{o}C until analysis.

Chemical Analysis

The proximate analyses were performed according to the following AOAC methods (Anonymous, 2014).The moisture content was determined according to AOAC 930.04 (Anonymous, 2014) by drying in an air oven maintained at 105±2 ˚C and dried at least for 2 hours until samples reached constant weight. Total fat content was determined gravimetrically by modifying AOAC 920.39 (Anonymous, 2014) after a continuous extraction process with petroleum ether using ANKOMXT20 Fat Analyzer (ANKOM Technology Corp.). Protein content was calculated over total nitrogen determined by a combustion–detection technique, AOAC 992.15 (Anonymous, 2014) by LECO FP-528 Nitrogen/Protein determinator using a conversion factor of 6.25. Dietary fiber content was determined using the Official Method 991.43 enzymatic-gravimetric method (Anonymous, 2014). Total ash (inorganic matter) content was determined using the AOAC 942.05 (Anonymous, 2014). The organic matter of the samples were removed by heating at 600 °C for 48 h. Available carbohydrate content was calculated by difference [100-(water + protein + fat + ash + alcohol + dietary fiber)] (Greenfield & Southgate, 2003).

Calcium, sodium, potassium, magnesium, phosphorus, copper, iron and zinc content of samples were determined according to Nordic Committee on Food Analysis (NMKL) Method, 186. A high-pressure microwave system (Berghof SW-4, Eningen, Germany) was used for digestion of samples. About 0.5 g sample was weighted into Teflon PFA vessels and 4 ml of the concentrated HNO3 65% (Suprapur, Merck, Darmstadt, Germany) and 2 ml of H2O2 30% (Suprapur, Merck, Darmstadt, Germany) were added for digestion. A five step programme was used for digestion using 30 Bar of pressure with a rising temperature from 130°C to 200°C gradually. The samples were cooled, filtered and each solution was diluted to 50 mL with deionized water. Ca, Na, K, Mg, P, Cu, Fe and Zn were measured by inductively coupled plasma mass spectrometer (Agilent 7500cx, Agilent Technologies, Santa Clara, CA). The ICP-MS instrument was equipped with micromist nebulizer, nickel sample and skimmer cones. Plasma power was 1550 W and argon flow rates of 15, 0.9, 0.16 L/min for the plasma, carrier and plasma gases, respectively.

Vitamin C analysis was performed according to procedure described by Gökmen *et al.* (2000), with little modification. Ten grams of each sample were weighed and extracted with 6% metaphosphoric acid in an ultrasonic bath for 20 min and then filtered before HPLC analysis. Vitamin C was analyzed by reverse-phase HPLC (Agilent 1100, Agilent Technologies, Santa Clara, CA) with UV-DAD detector at 244 nm. HPLC was performed using a C18 reversed-phase column (Hichrom C18; 150 mm x 4.6 mm, 5 µm particle size), a mobile phase of methanol and water containing tetrabutyl ammonium hydrogensulfate.

RESULTS AND DISCUSSION

Proximate composition

Proximate analyses of the wild edible plant species are summarized in Table 1. Moisture is the predominant component in plants. The high moisture supports chemical reactions, microbiological growth and it is directly reactant in hydrolytic processes, but provides positive properties such as taste and texture. The moisture contents of plants were determined between 77.9-92.0 g/100 g.

The highest ash (3.05 g/100 g) and carbohydrate (8.93 g/100 g) were obtained in *Polygonum cognatum* and *Ornithogalum umbellatum*, respectively. Fat contents were low and varied from 0.12 to 0.83 g/100 g in wild edible species. The protein contents ranged between 0.12-3.93 g/100 g and all of the species provide less than 10% of the Dietary Reference Intake (DRI) for protein (Anonymous, 2000). *Smilax excelsa* had the highest protein value (3.93 g/100 g). Compared with the protein contents reported by Ozbucak *et al.* (2007) for *S. excelsa* (7.28%), protein value was lower in the samples analyzed in this study. This may be due to populations, environment, genotype and environment interactions.

Smilax excelsa and *Polygonum cognatum* were notable for their high fiber contents (8.17 and 9.52 g/100 g respectively) providing a third of the DRI. The dietary fiber cotents for *Polygonum cognatum* and *Smilax excelsa* were notably higher than the dietary fiber results reported by Koca *et al.* (2015). Supplementing the diet with these species containing high fiber could be recommended due to its beneficial effects on health.

Minerals and Vitamin C

The detection and quantification limits of minerals determined are shown in Table 2. In this study, twelve wild plant species were analyzed for eight minerals. The concentrations of the minerals and vitamin C in plants are given in Table 3.

In the comparison of the concentration of minerals among wild edible plants, differences were observed. These variations could be from species, distribution of elements in the soil, environmental and weather conditions. K was the most abundant among the minerals quantified. Its concentration was between 256-709 mg/100 g in the plants analyzed. *Capsella bursa-pastoris*, *Smyrnium olusatrum* and *Glebionis coronaria* had the highest K content (709, 593 and 555 mg/100 g respectively. Al-Snafi (2015) reported an average value of K was 224.4 mg/kg for edible parts of *Capsella bursa-pastoris* which was lower than the results found in this study.

The concentration of Ca ranges from 46 to 275 mg/100 g. Ca is an essential nutrient because it is involved in the structure of the muscular system. Additionally, it controls essential processes like muscle contraction, cell growth, activity of brain cells and blood clotting (Belitz *et al.,* 2004). Similar result was found for *Capsella bursa-pastoris* (239.6 mg/100 g) by Al-Snafi (2015). Phosphorus content of samples studied ranged from 27.6 mg/100 g (*Beta maritima* L.) to 80.3 mg/100 g (*Capsella bursa-pastoris*).

Magnesium concentration varied from 15.2 to 77.8 mg/100 g in all samples. Some authors reported that the Mg contents of wild species were 0.20 g/100 g (*Smilax excelsa*), 0.23 g/100 g (*Polygonum cognatum*) Civelek and Balkaya (2013) and 38.17 mg/100 g for *Polygonum cognatum* (Turan *et al.,* 2003). These differences may be due to ecological factors and collection time.

Most of the wild plant species were excellent sources of several minerals, particularly iron. Fe was more than 10% of the DRI per 100 g of most of the species. *Polygonum cognatum* had highest iron content (37.4 mg/100 g) providing nearly 200% per cent DRI for male. Similar results were found for *Chenopodium album* (Yildirim *et al.,* 2001; Daur, 2015) and *Capsella bursa-pastoris* (Al-Snafi, 2015). However iron bioavailability should be considered while evaluating the iron content of foods. Iron deficiency may arise from low iron intake or by consuming foods from which iron is not well absorbed. Therefore bioavailability studies should be performed in order to provide consumers with reliable information on good food sources of iron.

Table 1. Proximate composition of the edible parts of wild edible plant samples (per 100g).
Çizelge 1. Yenilebilir yabani bitki türlerine ait örneklerin besin değerleri (100 g örnekte).

Species Tür	Moisture Nem (g)	Fat Yağ (g)	Protein Protein (g)	Carbohydrate Karbonhidrat (g)	Ash Kül (g)	Dietary fibre Diyet lif (g)	Energy Enerji (kcal/100g)
Ornithogalum umbellatum L.	87.0±0.3	0.27±0.04	0.53±0.01	8.93±0.22	0.84±0.04	2.45±0.03	45.1±1.0
Capsella bursa-pastoris (L.) Medik.	91.0±0.1	0.18±0.03	2.66±0.20	2.40±0.20	1.64±0.10	1.36±0.03	24.6±1.4
Polygonum cognatum Meissn.	77.9±0.2	0.65±0.05	2.06±0.04	6.77±0.23	3.05±0.01	9.52±0.12	60.3±0.6
Smilax excelsa L.	82.6±0.2	0.41±0.02	3.93±0.01	3.88±0.12	0.97±0.04	8.17±0.06	51.3±0.7
Beta maritima L.	89.2±0.9	0.18±0.02	2.42±0.08	1.26±0.05	1.64±0.06	5.27±0.48	26.8±1.2
Glebionis coronaria L. Spach	90.3±0.1	0.31±0.03	1.58±0.10	0.84±0.02	1.30±0.05	5.71±0.30	23.9±0.7
Smyrnium olusatrum L.	89.2±0.5	0.12±0.02	0.66±0.04	3.37±0.22	1.52±0.01	5.17±0.16	27.6±1.1
Cichorium intybus L.	91.1±1.1	0.28±0.03	0.53±0.08	2.12±0.17	1.54±0.07	4.45±0.55	22.0±0.9
Dioscorea communis (L.) Caddick&Wilkin	89.4±0.2	0.43±0.05	1.38±0.19	1.32±0.16	0.94±0.03	6.50±0.65	27.7±0.6
Tragopogon porrifolius subsp. Longirostris (Sch. Bip.)	87.5±0.2	0.83±0.05	0.15±0.01	5.41±0.39	1.52±0.04	4.70±0.38	38.5±0.6
Eremurus spectabilis M.Bieb.	92.0±0.5	0.46±0.03	0.12±0.01	4.06±0.19	0.73±0.01	2.75±0.31	25.9±1.1
Chondrilla juncea L.	89.8±0.3	0.70±0.03	3.22±0.04	3.61±0.34	1.32±0.04	1.37±0.05	36.4±1.6

Values are given as average and standard deviation of three independent composites (Ortalama ve Standart sapma değerleri 3 örnek ortalama değeridir).

Table 2. Mineral and Vitamin C content of edible parts of wild edible plant samples (mg/100g).
Çizelge 2. Yenilebilir yabani bitki türlerine ait örneklerdeki mineral ve C vitamini değerleri (mg/100g).

Species	Minerals (Mineraller)								Vitamin C
Tür	K	Ca	Na	P	Mg	Fe	Zn	Cu	
Ornithogalum umbellatum L.	256±30	128±1	5.5±0.5	36.8±1.9	19.5±.4.0	3.6±0.1	0.26±0.01	0.08±0.01	83.1±5.4
Capsella bursa-pastoris (L.) Medik.	709±67	249±42	3.7±0.5	80.3±6.1	47.5±6.7	7.9±1.1	1.30±0.18	0.17±0.04	62.7±2.1
Polygonum cognatum Meissn.	449±8	275±5	2.2±0.1	43.2±0.9	77.8±1.7	37.4±0.8	0.71±0.03	0.52±0.02	23.5±4.0
Smilax excelsa L.	436±17	69±3	1.6±0.1	60.6±2.5	22.7±0.9	1.5±0.1	0.77±0.03	0.40±0.02	2.0±0.6
Beta maritima L.	506±29	95±9	292±80	27.6±1.7	75.3±9.1	5.0±0.8	0.30±0.12	0.14±0.06	18.3±0.5
Glebionis coronaria L. Spach	555±11	239±31	198±48	46.5±9.4	53.4±11.7	8.7±1.9	1.97±0.18	1.77±0.37	10.2 ±2.9
Smyrnium olusatrum L.	593±39	180±9	2.9±0.1	46.1±4.7	37.5±1.3	3.7±0.1	0.25±0.04	0.22±0.04	75.3±10.3
Cichorium intybus L.	461±79	138±15	47.3±7.7	31.3±1.6	32.8±3.6	10.5±4.1	0.39±0.10	0.21±0.04	4.7±0.6
Dioscorea communis (L.) Caddick&Wilkin	444±9	46±1	1.4±0.1	72.3±1.5	27.0±0.5	1.2±0.1	0.59±0.01	0.17±0.01	36.5±3.4
Tragopogon porrifolius subsp. Longirostris (Sch.Bip.)	318±34	192±10	4.9±0.5	45.7±5.1	63.7±6.7	15.2±3.0	0.53±0.06	0.18±0.05	32.4±6.8
Eremurus spectabilis M.Bieb.	263±19	76±3	1.5±0.3	42.8±2.1	15.2±0.5	2.4±0.9	0.36±0.01	0.08±0.01	129.4±22.9
Chondrilla juncea L.	333±18	194±2	4.9±0.2	47.3±0.4	50.5±1.2	8.1±1.3	0.37±0.01	0.23±0.04	32.2±3.4

Values are given as average and standard deviation of three independent composites (Ortalama ve Standart sapma değerleri 3 örnek ortalama değeridir).

Table 3. Calibration information of elements.
Çizelge 3. Elementlere ait kalibrasyon bilgileri.

Elements Elementler	Mass Kütle	LOD Tespit limiti (µg/kg)	LOQ Tayin limiti (µg/kg)	R2	Concentration range Kalibrasyon aralığı (µg/l)
K	39	80	260.00	0.9999	1000-50 000
Ca	43	50	0.17	0.9998	1000-50 000
Na	23	50	0.15	0.9998	1000-50 000
P	31	40	0.12	0.0097	1000-50 000
Mg	24	90	0.32	0.9997	1000-50 000
Fe	56	21	68.70	0.9975	10-50
Cu	63	22	72.70	0.0095	10-50
Zn	66	16	52.20	0.9993	75-375

Glebionis coronaria and *Polygonum cognatum* provide high copper intakes and copper is involved in oxidation–reduction reactions which are important for life. Cu content varied from 0.08 to 1.77 mg/100 g. The highest contents of Zn (1.30 mg/100 g) were observed in *Capsella bursa-pastoris*. This value, as well as those found for *Capsella bursa-pastoris* were higher than the values reported by Al-Snafi (2015). A partially different Zn content from our result was reported by Phillips *et al.* (2014) and Daur (2015) for *Chenopodium album*; Civelek and Balkaya (2013) for *Smilax excelsa* and *Polygonum cognatum*.

Results showed that there were wide ranges of variations among the species regarding to mineral concentrations of the wild species studied. The highest mineral concentrations of edible wild plant species studied were determined in *Polygonum cognatum*, whereas the lowest concentration was *Ornithogalum umbellatum*.
Vitamin C content of the samples are highly variable ranging from 2.0 to 124.4 mg/100 g. Vitamin C was high in *Eremurus spectabilis* and *Ornithogalum umbellatum* relative to the other species and provides nearly 100% of the DRI per 100g. (75 mg/day for women and 90 mg/day for men), according to the Food and Nutrition Board (2000). Vitamin C is an essential water soluble protein and antioxidant either in the food or the human body, by the destruction of oxygen free radicals. Compared with the results reported by Sekereoglu *et al*. (2006), the vitamin C content was higher in *Ornithogalum umbellatum* samples analyzed in this study.

CONCLUSION

In this study a wide variability on nutrient content was obtained among the analyzed wild plant species. There are several factors known to affect the nutrient composition of foods; genetic factors, climate, geography, geochemistry, agricultural practices such as fertilizer use, stage of maturity, and the growth period. *Polygonum cognatum*, *Smilax excelsa* and *Eremurus spectabilis* are some of the species which can be highlighted for their high contribution to dietary fiber, microelement and vitamin C intake. The food composition data of wild plant species will be very helpful in promoting the use of more biodiverse foods for healthy diets in Turkey. The studied plant species could be a good alternative to other commonly consumed vegetables due to their high nutrient content. However, preparation methods and consumption ways are also important in the evaluation of their contribution to dietary requirements. Further studies should be performed on these species to demonstrate the effect of processing on nutrient composition.

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