Turkish Journal of Food and Agriculture Sciences

Turk J. Food Agric. Sci.
2019, 1 (1): 18-23
ISSN: 2687-3818 (Online)

Research Article

Mineral composition and nutritional properties of *Malva neglecta* and *Malvella sherardiana* consumed as vegetable in Central Black Sea Region of Turkey

Mehtap Özbakır Özer[1]*, Mine Aksoy[1]

[1] Black Sea Agricultural Research Institute, Samsun-Turkey

ABSTRACT

This study was conducted to determine nutrient content and macro-micro elements of mallow species consumed as vegetables in Central Black Sea Region. Survey and field studies were carried out in Samsun, Amasya, Ordu and Tokat provinces. In the survey studies, two species were identified in 30 mallow samples as *Malvella sherardiana* (8 materials), *Malva neglecta* (22 materials). Although mallow species showed similar values in terms of nutrient content and macro-micro elements, *M. sherardiana* was found to be higher. In the research, the highest amount of dry matter (20.9%), ash content (18.2%), N (3.2%) and protein contents (20.1%) in *M. sherardiana* and the highest vitamin C in *M. neglecta* (83.5 mg $100g^{-1}$) were determined. Mineral analysis showed that *M. sherardiana* contained considerably high amounts of potassium (3660.8 mg $100g^{-1}$), phosphorus (701.7 mg $100g^{-1}$), calcium (1730.0 mg $100g^{-1}$), magnesium (416.1 mg $100g^{-1}$), iron (22.4 mg $100g^{-1}$), sodium (687.7 mg $100g^{-1}$), copper (9.7 mg $100g^{-1}$), manganese (5.3 mg $100g^{-1}$) and zinc (10.1 mg $100g^{-1}$). In the research, mallow was found to be sufficient for human health with high protein, vitamin C and rich mineral content.

ARTICLE HISTORY
Received: 26 August 2019
Accepted: 16 September 2019

KEYWORDS
Edible wild plants
Macro- and microelements
Malva neglecta
Malvella sherardiana

*** CORRESPONDING**
mehtap_ozbakir@hotmail.com

1. Introduction

Turkish flora contains 10.754 plant species, 3.708 of which are endemic (Guner et al., 2000). It is one of the most important countries in the world in terms of plant species richness and endemic plants. Consumption of vegetables grows spontaneously in grassy weeds in nature are quite common in Turkey. Especially for people living in rural areas, it is both a source of food and a livelihood. These wild plants have both a cheaper and a much richer mineral content when compared to culture forms in terms of antioxidants, proteins, etc. Wild plants have been for a long time part of the human diet (Aberoumand and Deokule, 2009). These vegetables are widely used as traditional foods such as soups, pickles, dishes, pastries, salads and fried products. Also wild vegetables are popular foods for vegetarians (Demir, 2018).

Malva spp. species are also a source of natural antioxidant and nutritional properties and are widely used in high demand by the public (Guder, 2008). *Malvaceae* family includes the genera *Malva* L. and Malvella JAUB & SPACH. The genus *Malva* is represented by 26 species in all over the world and 9 species growing in Turkey (Davis, 1966). This plant is commonly used as vegetables and medicinal plants in Turkey. It is called as ebegumeci, develik, gomec, komec, ebegomeci and tolik by local people in Turkey (Hasimi et al., 2017). The mallow species usually grows on the edges of roads and fields, in grass, in uncultivated empty areas. It contains mucilage, glucose and pectin and has protective and softening effect due to its mucilage content (Kaya et al., 2004). Leaves and flowers has a wide range of usage area in the treatment of constipation, sore throat, women sterility, wound, hemorrhoids, miscarriage swellings, rheumatic pain, stomachache, abdominal pain, abscess, renal diseases, ease cough, throat infection, peptic ulcer, common cold, stomachache, bronchitis, indigestion in Turkey (Sezik et al., 1997; Simsek et al., 2002; Akaydın et al., 2013). Mainly fresh and young leaves added to salads or eaten in the cooked form (Demir et al., 2017).

Chemical composition and nutrient content of different mallow species in Turkey, has been determined by studies conducted by different researchers (Turan et al., 2003; Kaya et al., 2004; Özbucak et al., 2007; Civelek, 2011; Yucel et al., 2011; Pehlivan et al., 2013; Ceylan and Yücel, 2015; Koca et al., 2015; Demir, 2018; Tunçtürk et al., 2018).

In this study, mineral compositions and nutritional values of *Malva neglecta* and *Malvella sherardiana* commonly used in Central Black Sea Region were investigated.

2. Materials and methods

This study was conducted between 2011-2014. Plant samples were collected by field studies conducted in areas where natural and densely grown matter consumed in various forms in the Black Sea Region. Surveys were conducted in the spring of 2011 (April-May). Surveys were

ORCID
Mehtap Özbakır Özer: https://orcid.org/0000-0002-9519-2169
Mine Aksoy: https://orcid.org/0000-0002-3173-6577

carried out in Samsun, Ordu, Amasya and Tokat where mallow populations were intense in order to collect them from their natural environments and also benefited from Collection Form of Aegean Agricultural Research Institute. Five districts were selected from Samsun (Bafra, Çarşamba, Vezirköprü, Ladik, Havza), Ordu (Central district, Akkuş, Ünye, Ulubey, Perşembe), Amasya (Central district, Merzifon, Göynücek, Suluova, Taşova) and Tokat (Central district, Reşadiye, Niksar, Turhal and Erbaa) to be able to sample from different ecological and geographic areas as possible. As a result of material collection studies, thirty genotypes were obtained. Collection areas of mallow species were given in Table 1.

A label number was given to each collected plant material. This label was formed with license number of province that the sample taken from, the first two letters of the name of the county, stop number and number of samples taken, respectively (Balkaya, 1999). Then necessary analyses were done to determine nutritional characteristics of collected populations in Black Sea Agricultural Research Institute.

Flora of Turkey (Davis, 1967; Davis, 1978) was used for botanical diagnosis of the plants. In the survey studies, two species were identified in 30 mallow samples as *M. neglecta* (22 materials) and *M. sherardiana* (8 materials). The plants were harvested at the beginning of April and analyzes were made on leaves, and stalks. Then the plant samples were weighed to obtain fresh weight, placed in paper envelope. For measuring the dry matter contents of the plant materials, the samples were dried at 105 °C for 24 h in an oven. Dry matter content was calculated by subtracting percent moisture content from 100. Prior to analysis, the dried plant samples were ground to fine powder by using an electric grinder.

The ground samples were then packed in new plastic bags and stored at 4ºC in a refrigerator until use for analysis. The dried and ground samples were used for the chemical analyses, except for the determination of dry matter, moisture, pH and vitamin C content in which fresh samples were used. For mineral analysis, the plant samples were prepared by wet digestion method using H_2SO_4 and H_2O_2 (Kacar and Inal, 2008).

Table 1. Locations and GPS values where mallow genotypes were collected

Accession number	Counties	District	GPS Coordianates			Species
			Latitude	Longitude	Altitude (m)	
55BA01	Samsun	Bafra	41°31'439" N	35°58'482" E	82	*M. sherardiana*
55BA02	Samsun	Bafra	41°28'617" N	35°57'922" E	99	*M. neglecta*
55BA03	Samsun	Bafra	41°30'763" N	35°57'496" E	94	*M.neglecta*
55ÇA01	Samsun	Çarşamba	41°12'465" N	36°47'317" E	20	*M. sherardiana*
55ÇA02	Samsun	Çarşamba	41°12'427" N	36°46'717" E	19	*M. neglecta*
55ÇA03	Samsun	Çarşamba	41°12'183" N	36°43'681" E	23	*M. sherardiana*
55ÇA04	Samsun	Çarşamba	41°13'072" N	36°48'520" E	18	*M. neglecta*
55HA01	Samsun	Havza	40°59'471" N	35°45'164" E	700	*M. sherardiana*
55HA04	Samsun	Havza	40°59'174" N	35°41'522" E	713	*M. sherardiana*
55LA01	Samsun	Ladik	40°59'471" N	35°52'445" E	764	*M. neglecta*
55LA03	Samsun	Ladik	40°58'141" N	35°51'140" E	827	*M.neglecta*
55LA04	Samsun	Ladik	40°57'666" N	35°53'188" E	976	*M. neglecta*
55VE01	Samsun	Vezirköprü	41°02'580" N	35°31'103" E	630	*M. neglecta*
52AK01	Ordu	Akkuş	40°49'147" N	36°58'510" E	1097	*M. sherardiana*
52AK02	Ordu	Akkuş	40°48'258" N	36°59'736" E	1136	*M. neglecta*
52AK03	Ordu	Akkuş	40°52'547" N	37°03'581" E	1122	*M. neglecta*
52Mİ01	Ordu	Merkez	41°00'490" N	37°51'347" E	63	*M. neglecta*
52Mİ02	Ordu	Merkez	41°00'216" N	37°51'169" E	368	*M. neglecta*
52PE01	Ordu	Perşembe	41°05'520" N	37°38'496" E	130	*M. neglecta*
52UL01	Ordu	Ulubey	40°52'216" N	37°45'371" E	581	*M. neglecta*
60Mİ01	Tokat	Merkez	40°17'849" N	36°21'704" E	645	*M. neglecta*
60Mİ02	Tokat	Merkez	40°19'136" N	36°24'368" E	584	*M. neglecta*
60TU01	Tokat	Turhal	40°25'456" N	36°06'936" E	534	*M. neglecta*
05GÖ01	Amasya	Göynücek	40°28'536" N	35°34'252" E	500	*M. neglecta*
05Mİ01	Amasya	Merkez	40°36'280" N	35°56'398" E	731	*M. neglecta*
05Mİ02	Amasya	Merkez	40°33'221" N	36°03'162" E	782	*M. neglecta*
05Mİ03	Amasya	Merkez	40°32'370" N	35°40'026" E	423	*M. sherardiana*
05SU01	Amasya	Suluova	40°50'337" N	35°37'480" E	517	*M. neglecta*
05TA01	Amasya	Taşova	40°45'386" N	36°18'582" E	238	*M. neglecta*
05TA02	Amasya	Taşova	40°44'175" N	36°19'020" E	578	*M. sherardiana*

The content of Ca, Mg, Na, K, Fe, Cu, Zn and Mn were determined by atomic absorption spectrophotometer in the extract obtained by burning the dried and dried plant samples according to dry burning method (Kacar and İnal, 2008). Mineral contents of plant samples were calculated as mg 100 g^{-1} dry weight. Analyzes were done in three replicates.

After determining total N content by micro-Kjeldahl method, the data were multiplied by a coefficient of 6.25 and protein contents were calculated (Kacar, 1972). Ash content was measured by incinerating the dried sample in a muffle furnace at 550 ^{o}C for about 8 h until gray white ash was obtained. The pH of the samples was measured using a digital pH meter. All values except for pH were expressed as percentage. Vitamin C as total ascorbic acid was determined according to Cakmak and Marschner (1992) and mineral element concentrations of the plant materials were done by using atomic absorption spectrometry in terms of wet burn method. Analyzes were done in three replicates.

3. Results and discussion

Dry matter, pH, ash, total nitrogen, protein and vitamin C contents of the mallow species were presented in Table 2. The mallow species showed similarity in terms of pH values and found to have acidic structure. pH values of different mallow species were found in a wide range from 5.94 to 6.60 in previous studies (Turan et al., 2003; Kaya et. al., 2004; Demir, 2018).

Dry matter content depends on the structure of the plant tissue; for this reason, diversity in the dry matter content for different plant species is expected (Kibar and Temel, 2016). Dry matter contents in *M. sherardiana* and *M. neglecta* species were determined as 20.9 % and 20.3%, respectively. Some authors reported that the dry matter contents of mallow species were 23.1 % (M. sylvestris) Özbucak et al. (2007), 20.9 % (M. *neglecta*) Ceylan and Yucel (2015), 19.26 % (*M. sylvestris*) Tunçtürk et al. (2018).

Total ash contents may be thought of as an indicator of total mineral contents in the plant materials (Tunçtürk and Özgökçe, 2015).

The highest total ash content was determined in *M. sherardiana* (18.2 %), and the lowest content was found in *M. neglecta* (15.6 %). Similar result was found for *M. sylvestris* (20.0 %) by Kaya et al. (2004) and *M. sylvestris* (17.14 %) by Civelek and Balkaya (2013). The N content of mallow species collected from different localities was in the range from 2.7 to 3.2 %. The amount of nitrogen in plants is very important and varies according to plant type, climate and soil structure (Kibar and Temel, 2016).

Table 2. The concents of pH, dry matter (%), ash (%), N (%), protein (%) and vitamin C (mg/100g) in mallow species

Mallow species	pH	Dry matter (%)	Ash (%)	N (%)	Protein (%)	Vitamin C (mg/100g)
Malvella sherardiana	6.4±0.2	20.9±3.0	18.2±1.6	3.2±0.4	20.1±2.6	81.9±16.4
Malva neglecta	6.5±0.2	20.3±2.9	15.6±2.2	2.7±0.5	16.9±3.4	83.5±26.2

Özbucak et al. (2007) reported that the amount of *M. sylvestris* N is 3.5%. In another report, N contents were found to be 1.37 % in *M. sylvestris* by Tunçtürk et al. (2018). Proteins in which plants contain the food value. All of the mallow species have been found to have high protein content. The highest protein content was observed in *M. sherardiana* species (20.1 %). However, *M. neglecta* (16.9 %) possessed the lowest protein content. Some authors reported that the protein contents of mallow species were 26.25 % (*M. sylvestris*) Kaya et al. (2004); 22.33 % (*M. sylvestris*) Özbucak et al. (2007); 16.86 % (M. *neglecta.*) Yucel et al. (2011); 28.38 % (*M. sylvestris*) Civelek and Balkaya (2013); 26.02 % (*M. neglecta*) Ceylan and Yücel (2015). This result is similar to our result for the same species.

The ascorbic acid content of the mallow species showed similarity and was higher in *M. neglecta* (83.5 mg/100g) species. Ascorbic acid content was lower in *M. sherardiana* species (81.9 mg $100g^{-1}$). Pedersen (1998) and Keskin et al. (2015), mallow species explained that vitamin C is high. Demir (2018), found that the amount of vitamin C in *M. neglecta* 53.62 mg /100 g. In studies conducted by different researchers, it was determined that the amount of ascorbic acid of wild edible plants is high (Demir, 2006; Önen et al., 2010; Samancıoğlu et al., 2016; Borowy et al., 2017; Guzelsoy et al., 2017; Özbakır Özer and Aksoy, 2019a; Özbakır Özer and Aksoy, 2019b).

Foods that are vital for human nutrition are of mineral origin. Mineral substances in human nutrition, body development, growth and metabolic system (enzyme and hormonal structure, etc.) are required (Rutten, 1997). The mallow species were analyzed for their mineral content and the values of minerals expressed as mg/100 g dry weight are shown in Table 3.

The highest potassium content was determined to be 3660.8 mg $100g^{-1}$ in *M. sherardiana*, whereas the lowest potassium content was found in *M. neglecta* (2828.6 mg/100 g) (Table 3). Similar result was found for *M. sylvestris* (3017.2 mg $100g^{-1}$) by Akgünlü (2012). The values obtained for potassium content in the present study were higher than the values reported for other mallow (Turan et al., 2003; Civelek and Balkaya, 2013; Ceylan and Yücel, 2015; Demir, 2018). According to chemical analysis, the highest and the lowest magnesium values were observed in *M. sherardiana* and *M. neglecta*, respectively (Table 3).

The highest value of iron was determined in *M. sherardiana* (22.4 mg $100g^{-1}$) and the lowest value was determined in *M. neglecta* (19.2 mg $100g^{-1}$). In studies conducted by different researchers in Turkey have determined that showed variations for the content iron of their mallow species.

Table 3. Macro and micro nutrient contents of mallow species

Elements (mg $100g^{-1}$)	*M. sherardiana*	*M. neglecta*
K	3660.8±1037.4	2828.6±764.7
Mg	416.1±77.4	408.5±63.1
Fe	22.4±15.4	19.2±14.7
Zn	10.1±2.6	8.1±2.3
Mn	5.3±1.2	3.0±0.8
Cu	9.7±4.2	8.6±4.5
P	701.7±107.6	610.8±126.0
Na	687.7±107.2	610.2±107.9
Ca	1730.0±323.9	1519.9±271.7

Similar results were reported by Kaya et al., (2004) for *M. sylvestris*, Civelek (2011) for *M. sylvestris*, Pehlivan et al., (2013) for *M. neglecta*, Ceylan and Yücel (2015) for *M. neglecta* and Demir (2018) for *M. neglecta*. Manganese was found to be the lowest element among the minerals investigated. Manganese concentrations of the species studied varied between 3.0 and 5.3 mg $100g^{-1}$ (Table 3). Similar results were reported by Akgünlü (2012) for *M. sylvestris*. Some authors reported that manganese of wild edible species were *Borago officinalis* (3.6 mg $100g^{-1}$) by Medrano et al. (1992); *Tragopoxgom reticulatus* Boiss. (2.23 mg $100g^{-1}$) by Demir (2006), *B. corolliflora* (5.39 mg $100g^{-1}$) by Kibar and Temel (2016).

The highest value of zinc was determined in *M. sherardiana* (10.1 mg $100g^{-1}$) and the lowest value was determined in *M. neglecta* (8.1 mg $100g^{-1}$) (Table 3). Pehlivan et al. (2013), reported similar results for the zinc content of *M. neglecta* (8.49 mg kg^{-1}). All of the mallow species contained sufficient amount of copper. *M. sherardiana* was found to be the highest copper amount (9.7 mg $100g^{-1}$) among the mallow species. The general mean copper contents varied between 0.3-0.8 mg $100g^{-1}$ for leafy vegetables and 0.3 mg $100g^{-1}$ for edible plants (Kabata-Pendias and Pendias, 2001). Copper contents of various wild edible plants varied from 0.005 to 7.30 mg $100g^{-1}$ (Medrano et al., 1992; Turan et al., 2003; Demir, 2006; Sekeroglu et al., 2006; Coruh et al., 2007; Akgunlu, 2012; Tuncturk and Ozgokce, 2015; Özbakır Özer and Aksoy, 2019b). It was found that mallow was also rich in phosphorus. The phosphorus content of plants varied from 610.8 to 701.7 mg $100g^{-1}$ depending on the plant species. All the analyzed mallow species had considerable phosphorus contents, with the highest phosphorus level noted in *M. sherardiana* (701.7 mg $100g^{-1}$). Based on the report by Ceylan and Yücel (2015), phosphorus concentration of *M. neglecta* was in the concent of 428.75 mg kg^{-1}.

The highest sodium concentration was found in *M. sherardiana* while the lowest value was found in *M. neglecta*. Sodium contents were higher than the results of Tabaraki et al. (2012) and Tunçtürk et al. (2018) on mallow species. Mineral contents of mallow changed within broad limits according to both plant species and literature data on same plant species. This may be due to plant type, species, environmental conditions (soil mineral composition, soil type, the industrial zone, use of pesticides and fertilizers, climate, irrigation, lighting, temperature, aeration, pH, nutrient type and concentration of these nutrients, the mutual effects with each other, etc.) (Naidu et al., 1999; Marshall et al., 2004; Orech et al., 2007), differences in the ability of plants to absorb mineral substances (root structure, young-old plants, etc.), different amounts of minerals in different parts of the plant storage (leaves, stem and root) (Mohamed et al., 2003; Orech et al., 2007), it is also thought to be due to the sensitivity of the devices used in sample preparation and analysis (Guerrero et al., 1998).

The calcium concentrations of the analyzed plants ranged from 1519.9 to 1730.0 mg $100g^{-1}$, with the highest and the lowest calcium levels measured in *M. sherardiana* and *M. neglecta* respectively. Wild plants are reported to be richer in terms of some macro and micro elements compared to cultivated vegetables (Grivetti and Ogle, 2000; Flyman and Afolayan, 2006). Tabaraki et al. (2012), reported that the amount of Ca in *M. sylvestris* (823.05 mg $100g^{-1}$) species is high. They also stated that changes in mineral content may have a relationship with the growing environment.

4. Conclusions

In the study, it was determined that mallow species have a rich content in terms of mineral substances which affect human nutrition and health. These wild vegetables can contribute significantly those with in daily diets of poor people. More studies are needed to investigate the possibilities of cultivating wild vegetables in more demanding species.

Acknowledgement
Authors thank to General Directorate of Agricultural Research and Policies (TAGEM/TA/11/06/01/009) for their supports provided for this study.

Disclosure statement
No potential conflict of interest was reported by the author

References

Aberoumand, A., & Deokule, S. S. (2009). Studies on nutritional values of some wild edible plants from Iran and India Pak J Nutr., 8, 26-31.

Akaydın, G., Şimşek I., Arıtuluk, Z. C., & Yeşilada, E. (2013). An ethnobotanical survey in selected towns of the Mediterranean subregion (Turkey). Turk J Biol., 37, 230-47.

Akgunlu, S. B., (2012). Kilis ve Gaziantep yöresinde tüketilen bazı yabani sebzelerin mineral içerikleri ve mikrobiyolojik analizleri, Fen Bilimleri Enstitüsü, Biyoloji Anabilim Dalı, Yüksek Lisans Tezi, Kilis.

Balkaya, A. (1999). Karadeniz Bölgesindeki Taze Fasulye (*Phaseolus vulgaris* L.) Gen Kaynaklarının Toplanması, Fenolojik ve Morfolojik Özelliklerinin Belirlenmesi ve Taze Tüketime Uygun Tiplerin Teksel Seleksiyon Yöntemi İle Seçimi Üzerinde Araştırmalar. Doktora Tezi, Ondokuz Mayıs Üniversitesi, Fen Bilimleri Enstitüsü, 199s.

Borowy, A., Chwil, M., & Kapłan, M. (2017). Biologically active compounds and antıoxidant activity of borage (*Borago officinalis* L.) flowers and leaves. Acta Sci. Pol. Hortorum Cultus, 16(5), 169-180.

Cakmak, I., & Marschner, H. (1992). Magnesium deficiency

and high light intensity enhance activities of superoxide dismutase, ascorbate peroxidase, and glutathione reductase in bean leaves. Plant Physiol., 98, 1222-1227.

Ceylan, F., & Yücel, E. (2015). Düzce ve Çevresinde Gıda Olarak Tüketilen Yabani Bitkilerin Tüketim Biçimleri ve Besin Öğesi Değerleri. AKÜ FEMÜBİD 15, 1-17.

Civelek, C. (2011). Bafra Ovasında Sebze Olarak Kullanılan Yabancı Bitkilerin Toplanması. Bazı Besin İçeriklerinin Saptanması ve Islah Amaçlı Olarak Değerlendirilmesi. Yüksek Lisans Tezi, Ondokuz Mayıs Üniversitesi, Fen Bilimleri Ens. Bahçe Bitkileri Ana Bilim Dalı, 102s.

Civelek, C., & Balkaya, B. (2013). The Nutrient Content of Some Wild Species Used As Vegetables in Bafra Plain Located Black Sea Region of Turkey. Eur. J. Plant Sci. Biotechnol. Veg. Sci. Biotechnol. Turk., 7 (1), 62-65

Coruh, I., Gormez, A. A., Ercisli, S., & Bilen, S. (2007). Total phenolics, mineral elements, antioxidant and antibacterial activities of some edible wild plants in Turkey. Asian J. Chem., 19, 5755-5762.

Davis, P. H. (1966). Flora of Turkey and East Aegean Islands, Volume 2. Edinburgh University Press, Edinburgh. pp 179-242.

Davis, P. H. (1967). Flora of Turkey and the East Aegean Islands. Vol. 2, University of Edinburg, England.

Davis, P. H. (ed.), (1978). Flora of Turkey and the East Aegean Islands. Vol. 6, Edinburgh University Press, Edinburgh, 386-387.

Demir, H. (2006). Chemical composition of some wild (*Polygonum cognatum, Tragopoxgom reticulatus and Berberis vulgaris*) plants collected from Erzurum. Bahce, 35, 55-60.

Demir, E., Surmen, B., Özer, H., & Kutbay, H. G. (2017). Salıpazarı ve Çevresinde (Samsun/Türkiye) Doğal Olarak Yetişen Bitkilerin Etnobotanik Özellikleri. Karadeniz Fen Bilimleri Dergisi, 7(2), 68-78.

Demir, H. (2018). A Comparative Study of Chemical Compound of Some Edible Plants of the Eastern Anatolia Region of Turkey. Journal of Nutritional Health Sciences, 1(9), 1-12

Flyman, M. V., & Afolayan, A. J. (2006). The suitability of wild vegetables for alleviating human dietary deficiencies. South African Journal of Botany, 72(4), 492-497.

Grivetti, L. E., & Ogle, B. M. (2000). Value of traditional foods in meeting macro-and micronutrient needs: the wild plant connection. Nutrition Research Reviews, 13(1), 31-46.

Guder, A. (2008). Determination of antioxidant activity of plants and mixtures *Urtica dioica* L. and *Malva neglecta* Wallr. University of 19 May. Institute of Science. Department of Chemistry. Master of Science Thesis. 97-99

Guerrero, J.G., Martınez, J.G., Isasa, M.T. (1998). Mineral nutrient composition of edible wild plants. Journal of Food Composition and Analysis, 11(4), 322-328.

Güner, A., Özhatay, N., Ekim, T., & Başer, K. H. C. (2000). Flora of Turkey and the East Aegean Islands (Vol. 11). Edinburgh: Edinburgh University Press.

Guzelsoy, N. A., Ucurum, O., Tokat, E., Tan, A., Ay, S. T., & Ozbek, K. (2017). Nutritional Properties of some Wild Edible Plant Species in Turkey. Anadolu, 27(2), 39-45.

Hasimi, N., Ertaş, A., Oral, E. V., Alkan, H., Boğa, M., Yılmaz, M. A., Yener, I., Gazioğlu, I., Ozaslan, C., Akdeniz, M., & Kolak, U. (2017). Chemical Profile of *Malva neglecta* and *Malvella sherardiana* by Lc-MS/MS, GC/MS and Their Anticholinesterase, Antimicrobial and Antioxidant Properties with Aflatoxin-Contents. Marmara Pharmaceutical Journal 21(3), 471-484.

Kabata-Pendias, A., & Pendias, H. (2001). Tace elements in soils and plants, 3rd edition, Boca Raton, FL, USA: CRC Press.

Kacar, B. (1972). Bitki ve Toprağın Kimyasal Analizleri II. Bitki Analizleri. Ankara Üniversitesi Ziraat Fakültesi Yayınları, 453 pp.

Kacar, B., & Inal, A. (2008). Plant Analysis, Nobel Publishers, Ankara, Turkey, 892 pp.

Kaya, I., Incekara, N., & Nemli, Y. (2004). Ege Bölgesi'nde Sebze Olarak Tüketilen Yabani Kuşkonmaz, Sirken, Yabani Hindiba, Rezene, Gelincik, Çoban Değneği ve Ebegümecinin Bazı Kimyasal Analizleri. Yüzüncü Yıl Üniversitesi, Ziraat Fakültesi, Tarım Bilimleri Dergisi, 14(1), 1-6

Keskin, F., Cihanalp, C., Külcü, R., & Yilmaz, D. (2015). Ebegümeci Bitkisinin Bazı Fiziko Mekanik Özelliklerinin Belirlenmesi. 29. Ulusal Tarımsal Mekanizasyon ve Enerji Kongresi, 2-5 Eylül Diyarbakır, 403-407.

Kibar, B., & Temel, S. (2016). Evaluation of mineral composition of come wild edible plants growıng in the eastern Anatolia Region Grasslands of Turkey and consumed as vegetable. J. Food Process. Preserv., 40(1), 56-66.

Koca, I., Hasbay, I., Bostanci, S., Yilmaz, V. A., & Koca, A. F. (2015). Some Wild Edible Plants and Their Dietary Fiber Contents. Pak. J. Nutr., 14(4), 188-194.

Marshall, F., Agarwal, R., Te Lintelo, D., Bhupal, D. S., Singh, R. P. B., Mukherjee, N., & Singh, S. (2004). Heavy metal contamination of vegetables in Delhi. Executive summary of technical report.

Medrano, A., Masoud, T. A., Martinez, & M. C. (1992). Mineral and Proximate Composition of Borage. J. Food Compos. Anal., 5, 313-318.

Mohamed, A. E., Rashed, M. N., & Mofty, A. (2003). Assessment of essential and toxic elements in some kinds of vegetables. Ecotoxicology and environmental safety, 55(3), 251-260.

Naidu, G. R. K., Denschlag, H. O., Mauerhofer, E., Porte, N., & Balaji, T. (1999). Determination of macro, micro nutrient and trace element concentrations in Indian medicinal and vegetable leaves using instrumental neutron activation analysis. Applied radiation and isotopes, 50(5), 947-953.

Orech, F. O., Christensen, D. L., Larsen, T., Friis, H., Aagaard-Hansen, J., & Estambale, B. A. (2007). Mineral content of traditional leafy vegetables from western Kenya. International Journal of Food Sciences and Nutrition, 58(8), 595-602.

Önen, H., Geboloğlu, N., Parmaksız, İ., & Kaya, C. (2010). Orta Anadolu Orijinli Polygonum Cognatum Meissn. (madımak) Genotiplerinin Moleküler ve Agronomik Özellikleri İle Allelopatik Potansiyellerinin

Belirlenmesi. TOVAG - 105 O 502 Proje sonuç raporu

Özbakır Özer, M., & Aksoy, M. (2019a). Mineral composition and nutritional properties of *Trachystemon orientalis* (L.) G. Don populations in The Central Black Sea Region of Turkey. Acta Sci. Pol. Hortorum Cultus, 18(4), 157-167.

Özbakır Özer, M., & Aksoy, M., (2019b). Orta Karadeniz Bölgesi'nde Sebze Olarak Tüketilen Madımak (*Polygonum*) Türlerinin Beslenme Durumu. Yüzüncü Yıl Üniversitesi Tarım Bilimleri Dergisi, 29 (2), 204-212.

Ozbucak, T. B., Akcın, O. E., & Yalcın, S. (2007). Nutrition contents of the some wild edible plants in Central Black Sea Region of Turkey. Int. J. Nat. Eng. Sci., 1, 11-13.

Pedersen, M.1998. Nutritional Herbology: A Reference Guide to Herbs. ISBN10 1885653077

Pehlivan, M., Akgül, H., & Yayla, F. (2013).The Some Nutrient and Trace Elements Content of Wild Plants Using as Ethno botanical and Grown in the Gaziantep Region. Journal of Applied Pharmaceutical Science, 3 (04), 143-145.

Rutten, A. J. L. (1997). Adverse effects of nutrients. In Food Safety and Toxicity. Ed. by John De Vires, CRC Press, ISBN 0-8493-9488-0, 337 p., New York.

Samancıoglu, A., Sat, I. G., Yıldırım, E., Ercisli, S., Jurikova, T., & Mlcek, J. (2016). Total phenolic and vitamin C concent and antiradical activity evaluation of traditionally consumed wild edible vegetables from Turkey. Indian J. Tradit. Knowl., 15(2), 208-213.

Sekeroglu, N., Ozkutlu, F., Deveci, M., Dede, O., & Yılmaz, N. (2006). Evaluation of some wild plants aspect of their nutritional values used as vegetable in Eastern Black Sea Region of Turkey. Asian J. Plant Sci., 5, 185-189.

Sezik E, Yaşilada E, Tabata M, Honda G, Takaishi Y, Fujita T. (1997). Traditional medicine in Turkey VIII. Folk medicine in East Anatolia, Erzurum, Erzincan, Area, Kars, Iğdır Provinces. Econ Bot., 51, 195-211.

Şimşek, I., Aytekin, F., Yeşilada, E., & Yıldırım Ş. (2002). Anadolu'da Halk Arasında Bitkilerin Etnobotanik Bir Çalışma. 14. Bitkisel İlaç Hammaddeleri Toplantısı, Bildiriler, 29-31 Mayıs, Eskişehir, 434-457.

Tabaraki, R., Yosefı, Z., & Gharneh, H. A. A. (2012). Chemical Composition and Antioxidant Properties of *Malva sylvestris* L. Journal of Research in Agricultural Science, 8 (1), 59- 68

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

Tuncturk, M., & Ozgökce, F. (2015). Chemical composition of some Apiaceae plants commonly used in herby cheese in Eastern Anatolia. Turk. J. Agric. For., 39, 55-62.

Tunçtürk, M., Tunçtürk, M., Eryiğit, T., Kaya, A.R (2018). Mineral and Heavy Metal Constituents of Three Edible Wild Plants Growing in Van Province. Iğdır Üni. Fen Bilimleri Enst. Der., 8(2), 293-298.

Yucel, E., Tapırdamaz, A., Şengün, İ. Y., Yılmaz, G., Ak, A. (2011). Determining the usage ways and nutrient contents of some wild plants around Kisecik Town (Karaman/Turkey). Biol. Divers. Conserv., 4(3), 71-82.