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ORIGINAL PAPER

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NUTRIENT AND BIOACTIVE SUBSTANCE CONTENTS OF EDIBLE PLANTS GROWN NATURALLY IN SALIPAZARI (SAMSUN)

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ABSTRACT

This study was carried out for the determination of nutrient and bioactive substance contents of edible wild plants consumed as vegetables in Samsun's Salıpazarı district during September 2014 and August 2016 period. In the selected villages from identified locations, 11 species that naturally grow and are consumed as vegetables such as *Alcea apterocarpa* Boiss., *Rumex crispus* L., *Urtica dioica* L., *Trachystemon orientalis* L., *Oenanthe pimpinelloides* L., *Smilax excelsa* L., *Capsella bursa-pastoris* L., *Aegopodium podagraria* L., *Arum italicum* Miller, *Ornithogalum sigmoideum* Freyn et. Sint. and *Amaranthus retroflexus* L. have been identified. Protein, proline, free amino acid, superoxide dismutase (SOD) activity, lipid peroxidation level (MDA), glucose, sucrose, total soluble carbohydrate, chlorophyll, total carotenoids, β-carotene, lycopene, flavonoids, and anthocyanins contents of these plants were determined as 32.79–106.40 mg/g dry weight (DW), 5.71–47.66 μmol/g DW, 29.62–61.75 μg/g DW, 82.75–240.06 IU/mg protein, 106.36–531.05 μmol/g DW, 31.96–87.24 mg/100 g DW, 10.97–25.49 mg/100 g DW, 174.3–422.2 mg/100 g DW, 7.79–25.96 mg/100 g DW, 102.01–436.93 μg/100 g DW, 115.86–459.64 μg/100 g DW, 6.38–30.28 mg/100 g DW and 10.17–21.52 mg/100 g DW, respectively. As a result of the analyses, it was determined that there were significant differences ($P < 0.01$) in terms of all parameters examined among species.

Key words: carotenoids, β-carotene, edible wild herbs, protein, nutritional

INTRODUCTION

With the rapid increase of the human population in the world, unconscious use of plant resources, the use of weed medicines, natural disasters and urbanization lead to decrease and rapid loss of plant genetics [Özgen et al. 2004, Civelek 2011]. Many human-induced environmental problems have contributed to the importance of the concept of biological diversity. Biodiversity is the most important and most valuable natural resource for agriculture, medicine, science and technology for future generations. For this reason, genetic resources should be seen as common heritage of mankind. In addition, the protection of biodiversity naturally concerns the entire humanity, since there is no national boundaries in the environment surrounding the earth and a decline in a region will affect other regions as well [Kençe 1991].

The problem of feeding and the rapid growth of world population, despite changing environmental conditions, increase the importance and value of genetic resources. In recent years, there has been a tendency towards natural nutrition all over the world. With this tendency gaining strength, attention has also begun to be directed in non-cultivated plants growing spontaneously in nature. Thanks to the climatic

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diversity in the temperate zone, in Turkey with an extraordinary richness of the habitat, there are 11 707 plant taxa, of which 3649 are endemic [Güner et al. 2012]. In order to preserve the cultural heritage we have about the wild plants that survive in this richness and to be able to hand down to future generations, registration of species and varieties and determination of their place in human nutrition are very important.

Natural, high quality and balanced nutrition as well as the prevention or treatment of some diseases are very important. Foods contain varying proportions of protein, fat, carbohydrates, minerals and vitamins, along with a majority of antioxidant substances. Some foods containing antioxidants, which have an important place in human nutrition, are known to have therapeutic or protective effects [Yılmaz 2010]. The wild edible plants (herbs) have been commonly used as a food source since ancient times [Baloch et al. 2014]. Today, they are consumed as an indispensable constituent of human diet due to being readily available, easily and quickly cooked, inexpensive and having nutritional and medicinal values in all over the world [Redzic 2006, Akubugwo et al. 2007]. Turkey has a great diversity of wild edible plants and many of them are traditionally used in human nutrition as vegetables [Kibar and Temel 2015]. Nowadays, these plants have started to be sold more widely in the markets and grocery stores than before [Kaya and İncekara 2000]. Unfortunately, within our knowledge, detail informations are no available about the composition of these species in Turkey and the world. Because of all cited reasons, the aim of this paper is identified species, genus, and families of the main wild edible plants consumed as vegetables in the Salıpazarı district of Samsun. Their some composition properties such as protein, proline, free amino acid, SOD activity, MDA, glucose, sucrose, total soluble carbohydrate, chlorophyll, total carotenoids, β-carotene, lycopene, flavonoids and anthocyanins contents were investigated.

MATERIAL AND METHODS

In this study, land and survey studies were conducted in 2015 (September–October) and 2016 (April–August) in order to collect the edible wild plants consumed as vegetables by the people living in the district from the naturally grown environments in the Salıpazarı district of Samsun. For this purpose, firstly the public markets of the districts were visited and the plants presented for sale as vegetables were determined and the places where these plants collected were learned. Later on, through interviews with about 200 farmers living in various villages of the district, the plants consumed by the people of the region, the places where these plants were grown (Alanyaykın, Kalfalı, Kırgıl, Kocalar, Muslubey, Tepealtı and Yavaşbey) and harvesting times were determined. Enough material to be investigated in the research has been collected from the vicinage with the help of the people with sufficient knowledge and experience about local names, collec-

Table 1. Wild edible plants consumed as vegetables in and around Salıpazarı

Family	Latin name	Local name	Collection place	Consumed parts
Amaranthaceae	*Amaranthus retroflexus* L.	Sirken, Hoşkıran pancarı	Kalfalı Köyü	shoot, leaf
Apiaceae	*Oenanthe pimpinelloides* L.	Kazayağı, Gazyek	Kırgıl köyü	leaf
Apiaceae	*Aegopodium podagraria* L.	Mendek	Yavaşbey Köyü	shoot, leaf
Araceae	*Arum italicum* Miller	Nivik	Kırgıl Köyü	leaf
Boraginaceae	*Trachystemon orientalis* L.	Kaldırık, Galdirik	Alanyaykın köyü	stem, leaf, petioles
Brassicaceae	*Capsella bursa-pastoris* L.	Medik	Kocalar Köyü	leaf
Liliaceae	*Smilax excelsa* L.	Kırçan, Melocan	Alanyaykın köyü	leaf, petioles
Liliaceae	*Ornithogalum sigmoideum* Freyn et. Sint.	Sakarca, Kuzguncuk soğanı	Kocalar Köyü	corm, green parts
Malvaceae	*Alcea apterocarpa* Boiss.	Ebegümeci	Kocalar Köyü	shoot, leaf
Polygonaceae	*Rumex crispus* L.	Efelek	Salıpazarı merkez	leaf
Urticaceae	*Urtica dioica* L.	Isırgan	Tepealtı Köyü	leaf

tion and consumption of vegetables. Then, 11 species that are naturally grown and consumed as vegetables have been identified from the selected villages among the determined places in the region. The family, Latin name, local name, the collection places and consumed parts of these plants are given in alphabetical order in Table 1.

From each identified plant, approximately 2 kg fresh plants were collected in harvesting period, cleaned from the roots and the edible plants were sorted, washed with destilled water, water was drained. They were cut into small pieces and dried in an oven at 65°C until a constant weight. Then, the dried samples were ground into a fine powder using a laboratory mill. The ground samples were put into polyethylene bags, labelled, sealed and kept at 4°C until the analysis.

In the plant samples, protein contents were analyzed according to the method of Bradford [1976] using the Bio-RadR assay kit with bovine serum albumin as a calibration standard. The amount of proline was determined by the method of Bates et al. [1973], and the MDA was measured according to Lutts et al. [1996]. The amount of total free amino acids was calculated according to the method of Moore and Stein [1948].

In determining the enzyme activities of the samples, 0.5 g of sample was ground in liquid nitrogen and was homogenized with 5 ml buffer solution of 50 mm (pH = 7.6) KH_2PO_4 (pH = 7) containing 0.1 mm NaEDTA (Na-Ethylenediaminetetraacetic acid). The homogenized samples were centrifuged at 15 000 g and 4°C for 15 min. The SOD activity was measured by O_2 reduction of nitroblue tetrazolium chloride (NBT) under light, and the results were given as IU/mg protein [Cakmak et al. 2002].

Determination of the total soluble carbohydrate, glucose and sucrose contents was carried out using the Anthrone method [Hedge and Hofreiter 1962, Pearson et al. 1976]. To determine the chlorophyll content, 0.5 g of sample was thoroughly crushed in liquid nitrogen and homogenized by adding 10 ml of 80% acetone solution at 4°C. The homogenate was centrifuged at 3000 rpm for 10 min and the absorbance measurements of the supernatant taken at the spectrophotometer at 450, 645, 663 nm in triplicate. Arnon equation [Arnon 1949] was used to determine total chlorophyll content and the carotenoid amount was determined by Jaspars formula [Witham et al. 1971]. In spectrophotometre the absorbance properties of chlorophyll a (663 nm), chlorophyll b (645 nm) and carotenoids (450 nm) were quantitatively analyzed and the amount of pigment was calculated according to the following formulas:

$$\text{mg total chlorophyll (a+b)/g DW} =$$
$$= 20.2A_{645} + 8.02A_{663} \times (V/1000 \times W)$$

$$\text{mg total carotenoid/g DW} =$$
$$= 4.07A_{450} - 0.0435\text{chl a} + 0.367\text{chl b}$$

where A – absorbance, V – volume, W – sample weight, chl a – chlorophyll a, chl b – chlorophyll b.

β-carotene and lycopene were determined according to the method of Nagata and Yamashita [1992]. The dried methanolic extract (100 mg) was vigorously shaken with 10 ml of acetone – hexane mixture (4 : 6) for 1 min. The absorbance of the filtrate was measured at λ = 453, 505, 645 and 663 nm. Contents of β-carotene and lycopene were calculated according to the following equations:

$$\text{Lycopene (mg/100 ml)} =$$
$$= -0.0458A_{663} + 0.204A_{645} + 0.372A_{505} - 0.0806A_{453}$$

$$\beta\text{-carotene (mg/100 ml)} =$$
$$= 0.216A_{663} - 1.22A_{645} - 0.304A_{505} + 0.452A_{453}$$

where A – absorbance.

The values are expressed as μg/100 g (DW) of extract.

Total flavonoid determination was carried out spectrophotometrically [Kumaran and Karunakaran 2006]. 100 μl of the plant extract diluted with 10 mg/ml methanol was mixed with 20 μl of 100% of aluminum chloride, then 1 drop of acetic acid was added. A final volume of 5 ml was completed with methanol and allowed to stand for 40 min in room temperature conditions. The absorbance of the samples was read at 415 nm and the total flavonoid amount was expressed as mg quercetin equivalent (QE) with the graph obtained from standards (0.03125–0.5 mg/ml) prepared from quercetin. Anthocyanin contents were quantified by the modified method of Padmavati et al. [1997].

All analyses were performed in triplicates. SPSS 17.0 statistical software was used for statistical analysis on experimental results. Differences among means were evaluated by Duncan Multiple Range test.

RESULTS AND DISCUSSION

Protein, proline, free amino acid, SOD activity, MDA, glucose, sucrose, total soluble carbohydrate contents of these wild 11 species consumed as vegetables were investigated and significant differences between species were determined (Tabs 2 and 3). According to the obtained results, the highest protein content (106.4 mg/g DW) was determined in *O. sigmoideum* (Sakarca). The lowest protein content (32.79 mg/g DW) was found in *A. apterocarpa* (Ebegümeci) (Tab. 2). Protein contents of leafy vegetables such as spinach, lettuce, cabbage and rocket having an important place in human nutrition were found to be 26, 12, 12 and 36 mg/g (DW), respectively [Roe et al. 2013]. Turfan et al. [2016] reported that total soluble protein content of garlic was 38.4 mg/g. Compared with these values, protein contents of wild vegetables were found to be generally high (Tab. 2). Yıldırım et al. [2001] stated that protein contents of *Plantago minor* L., *Polygonum bistorta* L., *Astrodaucus orientalis* L. (Drude), *Camelina rumelica* Velen, *Lathyrus tuberosus* L., *Galium rotundifolium* L., *Chenopodium album* L. ranged from 3.50 to 6.75 g/100 g DW. Total protein content and composition of edible plants depend on biochemical variety, agrotechnics, kind and composition of soil, growing method, fertilization, raining frequency, the sowing and harvest dates. Also, the deficiency of nitrogen, phosphorus, potassium and sulphur in soil influenced the protein quality and quantity in vegetables [Eppendorfer and Bille 1996].

Once examined the proline content of edible herbs, the lowest proline content (5.71 µmol/g DW) was obtained from *T. orientalis* (Kaldırık) while the highest proline content was obtained from *C. bursa-pastoris* (Medik) with 47.66 µmol/g DW (Tab. 2). Proline is one of the most abundant amino acids in the protein of fresh leaves of different kale varieties and 434 mg proline/100 g (DW) was determined in kale leaves [Lisiewska et al. 2008]. In many studies, it was reported that there is a positive correlation between the synthesis of organic materials such as proline and the stress tolerance [Asraf and Foolad 2007, Jaleel et al. 2008, Huang et al. 2009, Topaloğlu 2010, Tuna and Eroğlu 2017]. For example, in a study about peppers grown under salt stress, proline content in control was 0.64 µmol/g (DW) whereas, in plants under salt stress, proline content was 4.56 µmol/g (DW) [Tuna and Eroğlu 2017].

Table 2. Protein, proline, and free amino acid contents, activity of SOD and MDA levels of the herbs consumed as vegetables

Species	Protein (mg/g)	Proline (µmol/g)	Total free amino acid (µg/g)	SOD (IU/mg protein)	MDA (µmol/g)
Amaranthus retroflexus	49.91 ±0.41f	9.38 ±0.04f	61.75 ±0.09a	100.88 ±0.67f	331.89 ±0.56ı
Oenanthe pimpinelloides	82.84 ±0.42b	37.42 ±0.08b	57.67 ±0.08b	189.95 ±0.35c	473.83 ±0.56d
Aegopodium podagraria	51.30 ±0.22e	21.07 ±0.06d	29.62 ±0.10f	118.74 ±0.23e	465.39 ±0.56e
Arum italicum	33.15 ±0.16g	11.90 ±0.02e	32.29 ±0.05e	82.75 ±0.26j	192.76 ±0.56k
Trachystemon orientalis	46.13 ±0.38f	5.71 ±0.02g	29.67 ±0.06f	90.79 ±0.26ı	371.72 ±0.56h
Capsella bursa-pastoris	61.24 ±0.29d	47.66 ±0.11a	30.05 ±0.05e	162.28 ±0.55d	531.05 ±0.56a
Smilax excelsa	75.68 ±0.38c	37.25 ±0.06b	51.12 ±0.12c	188.24 ±0.56c	106.36 ±0.56l
Ornithogalum sigmoideum	106.40 ±0.37a	29.62 ±0.11c	59.61 ±0.05a	220.30 ±0.83b	431.75 ±0.56f
Alcea apterocarpa	32.79 ±0.16g	12.44 ±0.02e	34.41 ±0.02de	97.63 ±0.35g	483.18 ±0.85c
Rumex crispus	52.97 ±0.21e	11.51 ±0.02e	30.60 ±0.09e	92.02 ±0.26h	527.87 ±0.85b
Urtica dioica	101.50 ±0.41a	28.64 ±0.08c	48.65 ±0.05d	240.06 ±0.79a	394.16 ±0.56g

The data are mean values ± standard deviation (SD) of three replicates expressed on dry weight basis. Means with different superscript letters within a row are significantly different at $P < 0.01$. IU – international unit

In consideration of the results obtained, the high content of proline in edible herbs suggests that these species if cultured, will be resistant to abiotic stress conditions. Proline, which is known to increase tolerance by stimulating defense systems against abiotic stress conditions in plant cells, also plays an important role in human nutrition and health [Volk and Stern 2004, Pardo et al. 2007].

The free amino acid contents of edible herbs varied between 29.62 and 61.75 µg/g DW and the highest value was determined in *A. retroflexus* (Sirken). The lowest values were obtained from *A. podagraria* (Mendek) – Table 2.

When SOD activity was examined, it was determined that the highest 240.06 IU/mg protein value was obtained from *U. dioica* (Isırgan) while the lowest 82.75 IU/mg protein value was obtained from *A. italicum* (Nivik) – Table 2. SOD activity is also an important element of antioxidative defense mechanisms developed by plants to eliminate or minimize damage of reactive oxygen species and is effective in eliminating antioxidative damage caused by salt stress conditions [Köşkeroğlu 2006, Tuna and Eroğlu 2017]. Another important effect of SOD activity is the effect of antioxidants on the passage through membranes. It has been observed that liposomal antioxidants containing SOD have at least 40 times more activity in the cell treatment within two hours than the others. It has been emphasized that intratumoral application of liposomes is a highly effective approach for the treatment of limited solid tumors [Ratnam et al. 2006, Yılmaz 2010]. In the study conducted by Turfan et al. [2016], the SOD value of the garlic was 22.35 IU/mg protein. Tuna and Eroğlu [2017] reported that SOD values increased from 8.75 to 17.49 IU/mg protein values with increasing salt concentration in pepper.

MDA varied from 106.36 (*S. excelsa*) to 531.05 µmol/g DW (*C. bursa-pastoris)* among the species (Tab. 2). In a study by Dutta et al. [2014], MDA levels were found to be 119 µmol/g in the cabbage under control, 381 µmol/g (DW) in the amaranth, 54.20 µmol/g (DW) in the radish and 564 µmol/g (DW) in the carrot. Researchers found that 10 mg/L arsenic application to these four species increased MDA of them. In peppers grown under salt stress, the MDA content released from cell membrane as the result of lipid peroxidation was stated to be increased [Tuna and Eroğlu 2017]. It was determined that resistance against stress conditions was lowest in the species with the highest MDA level.

In the determination of sucrose, glucose and total soluble carbohydrate content, the lowest values of 10.97 mg/100 g DW, 31.96 mg/100 g DW and 174.3 mg/100 g DW of sucrose, glucose and total soluble carbohydrate respectively were determined in *R. crispus* (Efelek). The highest value (87.24 mg/100 g DW) was observed in *O. sigmoideum* for glucose. The highest sucrose (25.49 mg/100 g DW) and total soluble carbohydrate (422.2 mg/100 g DW) contents were determined in *O. sigmoideum* and *U. dioica*, respectively (Tab. 3). Large variations in the sucrose, glucose and total soluble carbohydrate contents of the analysed species were observed. In some studies investigating the nutrient content of some vegetable species, it was determined that sucrose levels were <10 mg/100 g (DW) in spinach, lettuce and rocket. Glucose levels were determined as <10 mg/100 g (DW) in spinach and rocket, 60 mg/100 g (DW) in lettuce. The available carbohydrate values were found to be 20 mg/100 g in spinach, 140 mg/100 g in lettuce, <10 mg/100 g in rocket [Roe et al. 2013]. According to the obtained results, the glucose values of the edible wild plants (Tab. 3) were found to be higher than those of the cultivated vegetables. Sikora and Bodziarczyk [2012] determined the total carbohydrate content as 10.14 g/100 g (DW) in leaves of kale. In another study carried out, total carbohydrate contents of rocket and tomato were determined to be 3.27 g/100 g and 4.95 g/100 g, respectively [Hegazy et al. 2013]. Our results are in accordance with the results of Hegazy et al. [2013]. The composition of edible plants varies is depending on genetic factors, soil properties, climate, growing conditions, consumed plant parts, growth stage of the plant during collection and different analytical methods.

The total chlorophyll content of wild edible plants was in the range from 7.79 to 25.96 mg/100 g (DW), which was the highest in *Arum italicum* (Nivik) and the lowest in *Ornithogalum sigmoideum* (Sakarca) (Tab. 4). In a study carried out by Dutta et al [2014], total chlorophyll content in the seedling leaves of cabbage, amaranth, radish and carrot were detected to be 18.5, 45.3, 45.4 and 30.3 mg/100 g (DW), respectively. As a result, the total chlorophyll content, which is

Table 3. Glucose, sucrose and total soluble carbohydrate contents of the herbs consumed as vegetables

Species	Glucose (mg/100 g)	Sucrose (mg/100 g)	Total soluble carbohydrate (mg/100 g)
Amaranthus retroflexus	45.19 ±0.28g	11.17 ±0.21g	195.3 ±0.01e
Oenanthe pimpinelloides	78.47 ±0.41c	22.36 ±1.12b	359.9 ±0.01b
Aegopodium podagraria	55.92 ±0.94f	14.99 ±0.18e	242.7 ±0.01d
Arum italicum	41.38 ±0.20h	11.11 ±0.13gh	179.3 ±0.01g
Trachystemon orientalis	32.18 ±0.31j	11.46 ±0.19f	181.1 ±0.02f
Capsella bursa-pastoris	68.41 ±0.74d	20.03 ±0.19c	322.7 ±0.01c
Smilax excelsa	66.68 ±0.37e	19.26 ±0.14d	315.7 ±0.02c
Ornithogalum sigmoideum	87.24 ±0.36a	25.49 ±0.18a	411.1 ±0.01a
Alcea apterocarpa	32.49 ±0.15i	11.35 ±1.71f	183.9 ±0.01f
Rumex crispus	31.96 ±0.43k	10.97 ±0.13h	174.3 ±0.01g
Urtica dioica	79.46 ±0.52b	25.46 ±0.47a	422.2 ±0.01a

The data are mean values ± standard deviation (SD) of three replicates expressed on dry weight basis. Means with different superscript letters within a row are significantly different at P < 0.01

Table 4. Chlorophyll, total carotenoids, β-carotene, lycopene, flavonoid and anthocyanin contents of the herbs consumed as vegetables

Species	Chlorophyll (mg/100 g)	Total carotenoids (mg/100 g)	β-carotene (μg/100 g)	Lycopene (μg/100 g)	Flavonoid (mg/100 g)	Anthocyanin (mg/100 g)
A. retroflexus	15.36 ±0.12f	13.91 ±0.05e	148.12 ±0.15e	124.97 ±0.63fg	8.31 ±0.28g	10.47 ±0.03e
O. pimpinelloides	14.88 ±0.14f	13.45 ±0.04e	427.34 ±9.27a	459.64 ±4.89a	30.28 ±0.80a	15.14 ±0.04c
A. podagraria	20.51 ±0.11b	20.88 ±0.02bc	165.91 ±5.73d	236.63 ±1.24c	12.71 ±0.25d	16.01 ±0.05b
A. italicum	25.96 ±0.04a	25.75 ±0.01a	127.92 ±0.83f	271.57 ±0.48b	10.83 ±0.29e	21.52 ±0.09a
T. orientalis	19.15 ±0.25d	13.14 ±0.04ef	200.69 ±1.27c	133.71 ±0.63f	9.29 ±0.42f	15.05 ±0.22c
C. bursa-pastoris	17.62 ±0.06e	19.02 ±0.03d	102.01 ±0.36g	115.86 ±0.41g	13.76 ±0.29c	10.17 ±0.04e
S. excelsa	9.37 ±0.04g	7.75 ±0.03g	153.17 ±3.23de	176.41 ±1.43e	16.09 ±0.55b	14.56 ±0.04cd
O. sigmoideum	7.79 ±0.06h	11.93 ±0.07f	165.25 ±2.03d	231.34 ±0.55cd	6.38 ±0.74i	13.92 ±0.21d
A. apterocarpa	19.86 ±0.14c	19.75 ±0.12cd	207.88 ±6.11bc	228.24 ±7.26cd	8.25 ±0.30g	16.54 ±0.03b
R. crispus	18.57 ±0.81d	19.61 ±2.50 cd	220.01 ±0.14b	272.91 ±0.35b	7.19 ±0.39h	20.45 ±0.02a
U. dioica	21.07 ±0.10b	21.23 ±2.20b	436.93 ±9.57a	224.47 ±0.85d	7.08 ±0.31h	16.81 ±0.58b

The data are mean values ± standard deviation (SD) of three replicates expressed on dry weight basis. Means with different superscript letters within a row are significantly different at P < 0.01

important in human nutrition, has been detected in edible wild herbs at a higher rate than in cultivated vegetables.

Dietary carotenoids are thought to provide health benefits in decreasing the risk of disease, particularly certain cancers and eye disease. The health-beneficial effects of carotenoids are thought to be due to their role as antioxidants [Johnson 2002]. Some of the carotenoid compounds, for example β-carotene, have added benefits due their ability to be converted to vitamin A. The highest carotenoid content was obtained from *A. italicum* with 25.75 mg/100 g DW, while the lowest value was found in the *S. excelsa* with 7.75 mg/100 g DW (Tab. 4).

In the studies carried out, total carotenoid contents of cabbage (7.9 mg/100 g DW), radish (15.2 mg/100 g DW), carrot (9.7 mg/100 g DW), rocket (1.3 mg/100 g DW) and tomatoes (9.8 mg/100 g DW) were determined [Hegazy et al. 2013, Dutta et al. 2014]. Chanwitheesuk et al. [2005] investigated the total carotenoid contents of some species belonging to different vegetable families, and they reported the results as 2.52 to 3.89 mg% in the Araliaceae family, 1.29 to 8.92 mg% in the Asclepiadaceae family, 1.31 to 3.83 mg% in the Cucurbitaceae family, 2.54 to 10.80 mg% in the Labiatae family, 0.63 to 3.18 mg% in the Leguminosae family, 1.28 to 3.82 mg% in the Piperaceae family, 0.64 to 12.8 mg% in the Umbelliferae family and 0.64 to 1.91 mg% in the Zingiberaceae family. According to the results obtained, the total carotenoid contents of edible wild plants were found to be higher than the results reported by Chanwitheesuk et al. [2005].

The colour of yellow and orange fruits dependent on their β-carotene content [Johnson 2002]. In the body, this compound is converted to vitamin A, a powerful antioxidant that plays a critical role in maintaining healthy vision, skin and neurological function [Grune et al. 2010]. The highest content of β-carotene was determined as 436.93 μg/100 g DW in *U. dioica*, while the lowest was 102.01 μg/100 g DW in *C. bursa-pastoris* (Tab. 4). In a study, β-carotene content was determined to be 1553; 60; 1132 μg/100 g (DW) in spinach, lettuce and rocket respectively [Roe et al. 2013]. Sikora and Bodziarczyk [2012] found that the content of β-carotene ranged from 5.05–7.31 mg/100 g fresh weight in kale. In the comparison of β-carotene content in some vegetable species, the β-carotene content of edible wild plants appears to be at a considerable amount.

In our study, the content of lycopene varied between 115.86 and 459.64 μg/100 g DW. According to the obtained results, *O. pimpinelloides* had the highest content of lycopene (Tab. 4). In a study about nutritional values of vegetables and fruits by Roe et al. [2013], the lycopene contents of spinach, lettuce and rocket were determined as <10 μg/100 g (DW) and of tomatoes as 5842 μg/100 g (DW).

Flavonoids have powerful antioxidant effects and may help to protect the gastrointestinal tract against damage by reactive oxygen species within the stomach and intestines [Aberoumand and Deokule 2009]. The flavonoid content varied significantly among the species and ranged from 6.38 to 30.28 mg/100 g DW. The highest content of flavonoid was determined in *O. pimpinelloides* and the lowest in *O. sigmoideum* (Tab. 4). Chu et al. [2000] studied the flavonoid content of some vegetables. Their results were as follows: 63 mg/100 g (DW) in lettuce, 2.5 mg/100 g (DW) in spinach, 0.09 mg/100 g (DW) in Chinese broccoli, 0.11 mg/100 g (DW) in white round-headed cabbage, 2.71 mg/100 g (DW) in onion (inner leaves), 2.71 mg/100 g (DW) in onion (outer leaves) and 26.40 mg/100 g in (DW) purple cabbage. In another study, flavonoid contents were determined as 133.1 mg/100 g (DW) in Ceylon spinach, 56.4 mg/100 g (DW) in red onion and 10.4 mg/100 g (DW) in red pepper [Lin and Tang 2007]. Maisuthisakul et al. [2007] reported that the flavonoid values of 12 edible wild species varied between 3.6 and 25.5 mg/100 g (DW). In the same study, the highest value was obtained from *Cratoxylum formosum* Jack (Dyer) and the lowest value was obtained from *Hydrolea zeylanica* (L.).

According to our results, the highest and the lowest anthocyanin contents were determined in *A. italicum* with 44.38 μmol/100 mg DW and in *C. bursa-pastoris* with 21.59 μmol/100 mg DW (Tab. 4). Ersus [2004] reported that black carrots have a high anthocyanin content (125.17 mg/100 g (DW). In a study of the effect of light sources of different wavelengths on some nutrient contents of lettuce, it was reported that the content of anthocyanin in lettuce varied from 197 to 418 mg/100 g (DW) [Li and Kubota 2009]. Hodges et al. [1999], in their study of flavonoid contents in some vegetables, reported their results as: 104 mg/100 g (DW) in beetroot, 175 mg/100 g in eggplant, 197 mg/100 g in turnip, 163 mg/100 g in red cabbage and 27 mg/100 g in red pepperoni. Debnath and Ricard [2009] reported that the content of anthocyanins in different strawberry genotypes ranged from 6.3 to 43.7 mg/100 g (DW).

CONCLUSIONS

As in many part of the world and in Turkey, the local people in the Central Black Sea Region is assessing the wild edible species in different ways as food source. During the visits to the district markets, it has been noticed that some species such as *T. orientalis* (Kaldırık), *S. excels* (Kırçan) and *P. cognatum* (Madımak) were sold at high prices in the markets. This is an indication of intense demand for these species, especially by people in the region. This demand is thought to be due to the desire of humans to naturally and balancedly nourish by hearing that the medicinal properties of wild species and plant nutrient values are high.

In order to determine the nutrient content of plants that is one of the reasons for consumption of wild vegetables, proline, free amino acid, MDA, glucose, sucrose, total soluble carbohydrate, total carotenoids, β-carotene, lycopene, flavonoids, anthocyanins content and SOD activity of 11 species were analyzed in this study. Values for the highest protein, glucose, sucrose and total soluble carbohydrate were determined for the *O. sigmoideum*. The highest proline and MDA values were obtained from *C. bursa-pastoris*. The highest free amino acids were obtained from the plants of *A. retroflexus*. The highest β-carotene, lycopene and flavonoid values were determined in the *O. pimpinelloides*. The highest values of chlorophyll, carotenoid and anthocyanin were found in *A. italicum* and the highest SOD values were obtained from the *U. dioica*.

It has been determined that the nutritional values of wild plant species examined in the region have higher nutrient contents than some cultivated vegetable species. According to the results obtained, it was determined that *Ornithogalum sigmoideum*, *Oenanthe pimpinelloides* and *Arum italicum* are very important for human nutrition. For this reason, it is suggested to carry out more studies to investigate the cultivation possibilities of wild plants.

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