Indian Journal of Traditional Knowledge
Vol. 15(2), April 2016, pp. 208-213

Total phenolic and vitamin C content and antiradical activity evaluation of traditionally consumed wild edible vegetables from Turkey

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Received 06 April 2015, revised 28 August 2015

Cultivation of wild edible vegetables, traditionally used as food, should increase in agriculture, as they have valuable nutritional content and contain bioactive compounds. Notably, wild edible green vegetables play a significant role in conventional diets. They are abundant in phenols and show high antiradical activity. The aim of this study was to determine the DPPH radical-scavenging activity, total phenolic content (TPC), and vitamin C content in 21 wild edible plants collected from Bingol province of eastern Turkey. As far as we know, this is the first report that presents useful data of interest for furthering the knowledge of the DPPH radical-scavenging activity, TPC, and vitamin C content of these species, traditionally consumed in the many districts in Bingol province. According to the results, the content of TPC, Vitamin C and level of DPPH radical-scavenging activity is higher in leaves than in stems of the edible greens. *Rumex acetosella* L., *Rumex scutatus* L. and *Rumex pulcher* L. are rich in vitamin C; *Rumex pulcher* L., *Nasturtium officinale* R. Br. and *Chenopodium album* L. had higher TPC and high antioxidant characteristic. *Rumex pulcher* L., *Anchusa azurea* Miller *var. azurea* and *Rumex acetosa* L. showed promising DPPH radical-scavenging activity. These new findings suggest that these wild edible vegetables can show valuable antioxidant and antiradical activity in the traditional ways of their consumption.

Keywords: Wild edible vegetables, Folk Medicine, DPPH radical-scavenging, Traditional use

IPC Int. Cl.[8]: A61K 36/00, C09K 15/00, A23B 7/00, C07D 307/62

Horticultural plants including fruits, vegetables and grapes have long been valued part of a nutritious and tasty diet[1,2]. There is increasing scientific awareness that traditionally used wild vegetables play an important role in human nutrition and health and they are natural sources of antioxidants. This feature of plants is due to their high content of phytochemicals including phenolic acids, ascorbic acid, flavonoids, carotenoids, and tocopherols[3,4,5]. Studies performed on traditionally used wild vegetables in different parts of the world including India, Turkey, Tanzania, Nigeria, etc., have shown that many of these species have higher protein, mineral and vitamin content than the cultivated vegetables like spinach and cabbage[6,7,8]. More recently there was an increased interest to determine their importance for human nutrition, nutritional content and health-promoting properties[9,10,11].

Turkey located between Asia and Europe continent has diverse climate and soil conditions. It is estimated that the country has 9,000 vascular plant species. Thanks to this Turkey belongs to one of the world's highest plant biodiversity areas. Most of the wild edible plants are traditionally used as food particularly in the Eastern Anatolia region, which has a rich tradition of using wild edible vegetables as foods for nutrition[6,12,13]. Specific conditions of the region probably resulted into paradoxical situation: insufficient crop yields, caused by adverse climatic and inappropriate topographic conditions led to widespread appreciation of nutritional properties of the numerous wild edible vegetables. People living in Eastern Anatolia region arefar away from industry areas, and they have been using wild edible vegetables traditionally for a long time. Wild edible vegetables are an important part of their life. They sometimes consumed wild edible vegetable as raw,

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but more frequently they cooked it, boiled it and seasoned it with olive oil, fried it or mixed it with other ingredients[14,15,16]. In the region plants are collected and are either consumed directly or sold to consumers in rural markets.

The aim of the present study is to provide complete data of antiradical activity, total phenolic content and vitamin C content of 21 wild vegetables for Bingol province in Eastern Anatolia region of Turkey. Moreover, as far as we know, this is the first report dealing with determination of total phenolics, vitamin C content and DPPH radical-scavenging activity of 21 wild vegetables traditionally consumed as food in Bingol province.Various records on the traditional knowledge of wild edible vegetables including local names, edible part used for cooking and ways of traditional use by local peoples are reported. Therefore, keeping the above facts in the mind, the present study was conducted.

Materials and methods

Collecting the plant material

Wild plants were collected from Bingol, part of Upper Euphrates, Eastern Anatolia region Turkey, fromthe middle of April to late May 2013. The station is located on 41°20' and 39°54' N with 38°27' and 40°27' E. The plant species were collected from mountains, cultivated fields, river edges, roadsides and pastures. Regarding their high cultural relativity, shown in previous ethnobotanical studies[13,17], 21different species of wild edible vegetables traditionally used in Bingol province were chosen (Table 1). Their edible partswere harvested and their

Table 1—Wild plant species, their utilized parts and ways of preparation

Species	Local name	Family	Edible part	Ways of preparation
Ferula orientalis L.	*Helliz, Çakşır, Pohuk*	Apiaceae	S, R	Pickle, Stew
Scorzonera tomentosa	*Nerbend, Nerabent*	Asteraceae	A	Roasted with egg, Stems eaten raw after removing the skin
Mentha longifolia subsp. *Typhoidesvar typhoides*	*Pung, Pune*	Lamiaceae	A	Salad, Stew with Yogurt, Raw, Pie, Soup
Nasturtium officinale R. Br	*Kijı, Qije, Tujik*	Brassicaceae	A	Roasted, Salad
Chenopodium album	*Sirken*	Chenopodiaceae	A	Stew, Roasted
Rumex scutatus L	*Ekşimik*	Polygonaceae	L	Salad, Raw
Rumex acetosella L.	*AcıTırşik*	Polygonaceae	L	Stuffed, Pie, Soup, Meal, Salad, Roasted
Rumex patientia L	*DolmalıkTırşik*	Polygonaceae	L	Stuffed, Pie, Soup, Meal, Salad, Roasted
Rumex pulcher L. ssp. *pulcher*	*Gulsik*	Polygonaceae	L	Salad, Raw
Rumex acetosa	*KuzuKulağı*	Polygonaceae	L	Salad, Raw
Rheum ribes	*Rıbes, Rıwes, Rewas,Işgın*	Polygonaceae	S	Stems eaten raw after removing the skin
Anchusa azurea Miller var *azurea*	*Gezun, Gelezun*	Boraginaceae	L,B	Roasted
Polygonum cognatum Meissn.	*Madımak*	Polygonaceae	A	Meal, Round, Flat bread
Amaranthus retroflexus L.	*Selmik, Horozibiği*	Amaranthaceae	S, L	Stew, Meal, Pie, Salad
Sium sisarum L. var *lancifolium*	*Vınyek, Vınık, Tırwaş,*	Apiaceae	A	Meal, Roasted with egg
Tragopogon longirostris Bisch ex Schultz Bip. var *longirostris*	*Marşing, Sıpıng,Yemlik*	Asteraceae	S, L	Salad, Stew with yogurt, Raw
Allium ampeloprasum L.	*Sir, Sirüm*	Liliaceae	A	Meal, Salad, Raw, Roasted with egg
Ferula elaeochytris	*Cağ*	Apiaceae	S	Roasted, Meal, Pickle
Urtica dioica	*Gerzinık, Derzinık, Isırgan*	Urticaceae	A	Pie, Meal, Roasted With Egg, Salad, Soup
Eremurus spectabilis	*Çiriş, Heluk, Gullık*	Liliaceae	A	Roasted, Meal, Pickle
Heracleum trachyloma	*Helerg, Lerg (Poğluk)*	Apiaceae	S, L	Roasted, Meal

Edible part: A: above ground, S: Stem, L: Leaves, R: Root, B: Branch non-edible parts were eliminated. 21 specimens of each species were randomly chosen to prepare samples. Each batch consisted of at least 500 gm of edible partof the plants, i.e., basal leaves, young leaves and stems, or mid-ribs of basal leaves, depending on the species (Table 1), all with a healthy external appearance. They were collected at the optimum time for harvesting, when the edible parts were large enough. After collecting and preparation, each sample was packed in plastic bag and transported to the laboratory in a cooled environment within one day. To facilitate handling and preservation, samples were immediately freeze-dried and preserved at -20°C in a dark, dry ambience.

Determination of total phenolics and antioxidant (antiradical) activity

Homogenates obtained with a blender were extracted with acetone, water, and acetic acid (70:29.5:0.5, v/v/v) for 1 hr in darkness[18]. This extract was filtered and used for phytochemical analysis. Total phenolics were determined with colorimetric assay using Folin-Ciocalteu reagent as described by Slinkard and Singleton[19]. Gallic acid was used as standard, and results were expressed as mg of gallic acid equivalents per 100 gm of fresh weight basis.

The total antioxidant (antiradical) capacity of samples was determined by 2,2-Di phenyl-1-picrylhydrazyl radical (DPPH•) assays. In the DPPH assay, 50µL of various concentrations of the extracts in methanol were added to 5 mL of a 0.004% methanol solution of DPPH. After a 30 minute incubation period at room temperature, the absorbance was measured against a blank at 517nm. DPPH in per cent (%) was calculated as follows:

$$DPPH\% = (A_{blank}-A_{sample}/A_{blank}) \times 100$$

Where, A_{blank} is the absorbance of the control reaction (containing all reagents except the test compound), and A_{sample} is the absorbance of the test compound. EC_{50} is the effective concentration in µg extract/mL (µg extract for EC_{50} in 1mL of DPPH solution) that inhibits the DPPH activity by 50%. EC50 is calculated from the plot of scavenging activity against extract concentration and represents the amount of extract necessary to decrease the initial DPPH concentration by 50%. Tests were carried out in triplicate. Results were expressed as (EC_{50})[20].

Vitamin C

Ascorbic acid (Vitamin C) content in samples was quantified with a Merck reflectometer set (Merck RQflex).

Statistical analysis

The experiment had a completely randomized design with 4 replications. Data were processed using the analysis of variance (ANOVA), and means were separated by Duncan multiple range test at $P < 0.05$ significant level.

Results and discussion

The DPPH radical scavenging effects of wild edible vegetables are given in Table 2. There were statistically significant differences among samples in terms of antiradical activity (Table 2). The antiradical activity of the wild edible vegetables varied from 12.61 (*Polygonum cognatum* Meissn.) to 448.10 (*Rumex pulcher* L. ssp. *pulcher*) indicating *Polygonum cognatum* Meissn. had the strongest antiradical activity among plant species used, while *Rumex pulcher* L. ssp. *pulcher* showed the lowest activity. The lowest and highest antiradical activities of *Polygonaceae* family ranged from 12.61 (*Polygonum cognatum* Meissn.) to 448.10 (*Rumex pulcher* L.) and of *Apiaceae* family from 24.69 (*Sium sisarum* L. *var lancifolium*) to 62.84 (*Ferula elaeochytris* L.), respectively (Table 2). The highest DPPH radical scavenging activity may be caused by a higher H binding capacity of samples against the DPPH radical[21]. Compared with the other authors, Morales *et al.*[4] reported high DPPH scavenging activity for *Anchusa azurea* and *Rumex pulcher* L and Isbilir and Sagir[22] reported for *Rumex acetosella* L.

Total phenolic content of the wild edible vegetables varied considerably among families (Table 2). In general there were relationships between antioxidant activity and total phenolic content (Table 2). Among the leafy vegetables, the highest total content of phenolics was found in *Rumex pulcher* L. (141.24 mg GAE/100 gm) followed by *Nasturtium officinale* R. Br (126.35 mg GAE/100 gm) and *Chenopodium album* (103.00 mg GAE/100 gm), while *Anchusa azurea* Mill. *var. azurea* revealed the lowest one (0.37 mg GAE/100gm) (Table 2). We found 73.66 mg GAE/100 gm of total phenolics in *Rumex acetosella* L. and Isbilir and Sagiroglu[22] reported the total content of phenolics as 69.21 mg GAE/100 gm in same species, which is lower than our results, indicating lower support for their use as a functional food.

The average total phenolic content of our traditionally used 21 wild edible vegetables was 60.17 mg GAE/100 gm (Table 2), which are higher

Table 2—Total phenolic content, antiradical activity and vitamin C content of examined plant species (fresh weight basis)

Species	Vitamin C (mg/100gm)	DPPH (EC_{50})	TPC (mgGAE/100gm)
Allium ampeloprasum L.	14.66 ±1.45cde	41.46±0.26h	47.33±1.85h
Amaranthus retroflexus L.	13.33±1.33de	58.03±0.77ef	64.00±2.64ef
Anchusa azurea Miller var *azurea*	12.23±1.20de	178.96±0.79b	0.35±0.06k
Chenopodium album	12.45±0.57e	18.66±1.20lm	103.00±2.64c
Eremurus spectabilis	18.00±2.08c	30.86±1.93ıj	32.34±0.89i
Ferula elaeochytris	13.66 ±1.20de	62.33±1.45e	70.08±3.21e
Ferula orientalis L.	11.00±0.57e	50.66±3.84gm	90.20±3.51d
Heracleum trachyloma	12.66±0.48de	32.33±0.88i	23.37±1.37j
Mentha longifolia subsp. *typhoides var typhoides*	12.33±0.88de	25.66±1.76k	92.03±3.21d
Nasturtium officinale R. Br	13.33±1.20de	24.66±1.45kl	126.35±3.84b
Polygonum cognatum Meissn.	12.33±1.88de	12.00±1.00n	86.50±6.08d
Rheum ribes L.	12.33±0.76de	32.66±1.45i	23.32±3.05ij
Rumex acetosa	12.66 ±0.97de	155.00±5.77c	17.07±2.64j
Rumex acetosella L.	72.00± 3.05a	15.66±0.88mn	73.66±6.43e
Rumex patientia L	12.13±0.57e	152.00±4.72c	33.36±3.17i
Rumex pulcher L. ssp. *pulcher*	28.20±1.15b	448.33±0.66a	141.24±9.29a
Rumex scutatus L.	30.66±2.32b	26.66±0.65k	45.40±2.88h
Scorzonera tomentosa L.	12.17±0.58e	54.66±1.45gm	49.67±1.45gh
Sium sisarum L. var *lancifolium*	13.23±1.23de	23.66± 2.18kl	95.37±2.84cd
Tragopogon longirostris Bisch ex Schultz Bip. var *longirostris*	14.80±0.77de	71.00±3.60d	48.68±3.84gh
Urtica dioica	16.40±2.30dc	48.66±1.20gm	58.63±2.33fg

Means within a column followed by the same letter do not significantly differ at p=0.05

values compared to the some other wild edible vegetables[4,23] and for the some other *Rumex* species[22]. Total phenolic content of *Chenopodium album* and *Polygonum cognatum* was found similar to the results of Afolayan & Jimoh[8] and Coruh *et al*.[15]. The differences could be explained by the variability of growing areas, plant parts used (stems, flowers, leaves and fruits), solvents and methods used[24].

Among the secondary metabolites generated by plants, phenolics are those that best contribute to the bitter, sour or astringent tastes (these substances mostly accumulate in leaves and shoots but also in flowers and roots). They also provide a defense against herbivorous predators[25], and contribute to personal health and diet[26]. Flavonoids, flavonols, tannins and other polyphenolic constituents are also valued antioxidant components of these wild edible vegetables[3].

Vitamin C content of some wild edible vegetables abundantly consumed in the Bingol province in East Anatolia of Turkey was determined and the results were given in Table 2. There were significant differences among the plant samples. Vitamin C content varied between 11mg/100 gm (*Ferula orientalis* L.) and 72 mg/100 gm (*Rumex acetosella* L.) indicating high diversity in the value of this parameter. As indicated in Table 2, the highest value of Vitamin C (72 mg/100 gm) was detected in *Rumex acetosella* L., followed by *Rumex scutatus* L. (30 mg/100 gm) and *Rumex pulcher* L. *ssp.* pulcher (28 mg/100 gm). Morales *et al*.[4] reported that *Rumex pulcher* had 35.07 mg/100 gm vitamin C content in Spain. In this study, *Allium ampeloprasum* had vitamin C content14 mg/100 gm. García-Herreraet *et al*.[5] showed vitamin C fluctuations in *Allium ampeloprasum* edible parts, ranging from 2.37 to11.54 mg/100 gm. Vitamin C is naturally present in some foods, in particular horticultural crops and humans are unable to synthesize vitamin C endogenously, therefore it is an essential dietary component. Due to its function as an antioxidant and its importance for the immune system, vitamin C has been promoted as a mean to help prevent and/or treat numerous health conditions. Humans (adults and children aged 4 and older) need 60 mg vitamin C daily. Thus, the 21 wild edible vegetables used in this study can be accepted as a rich source of vitamin C. Some vegetables can be eaten raw but most are commonly cooked before being consumed. Generally, preparation of vegetables at home is based on taste preference and convenience rather than retention of nutrient and health-promoting compounds. Many vegetables contain vitamin C, but excess amount of heat can destroy the vitamin completely. At high temperature, in the presence of sunlight and oxygen in air, vitamin C reacts and it is oxidized. Cooking in high temperature also destroys vitamin C asit easily leaches into the cooking water being a water-soluble vitamin. As indicated in Table 1, most of these wild edible fresh leaves are eaten as salad for its acidulous taste in the Bingol province in Turkey. In different regions of Turkey, many wild edible plants are consumed as a good source of vitamins and minerals, especially for children, when cultivated vegetables are not as easily available.

Conclusion

Medicinal profit of wild edible plants including their contribution to health has been known for a long time. This study showed that some of the wild edible vegetables analyzed are good sources of vitamin C (in the case of *Rumex acetosella* L., *Rumex scutatus* L. and *Rumex pulcher* L.) and total phenolic content (*Rumex pulcher* L., *Nasturtium officinale* R. Br. and *Chenopodium album* L.). *Rumex pulcher* L., *Anchusa azurea* Mill. *var*. *azurea* and *Rumex acetosa* L. showed promising DPPH radical-scavenging activity. In *Rumex* species, which are being consumed as food already (green leaves), antiradical activity was higher than in other wild vegetables analyzed. These findings are able to provide scientific evidence for those who use these plants in the treatment of health problems. Besides, remarkable nutritional values could help in increasing the vegetable consumption and public health.

References

1 Bacvonkralj M, Jug T, Komel E, Fajt N, Jarni K, Zivkovic J, Mujici I & Trutic N, Effects of ripening degree and sample preparation on peach aroma profile characterization by headspace solid-phase microextraction, *Turk J Agric For,* 38 (2014) 676-687.

2 Rop O, Ercisli S, Mlcek J, Jurikova T & Hoza I, Antioxidant and radical scavenging activities in fruits of 6 sea buckthorn (*Hippophae rhamnoides* L.) cultivars, *Turk J Agric For,* 38 (2014) 224-232.

3 Halvorsen BL, Holte K, Myhrstad MCW, Barigmo I, Hvattum E & Remberg SF, A systematic screening of total antioxidants in dietary plants, *J Nutr,* 132 (2002) 461-471.

4 Morales P, Ferreira ICFR, Carvalho AM, Sánchez-Mata MC, Cámara M, Fernández-Ruiz V, Pardo-de-Santayana M & Tardío J, Mediterranean non-cultivated vegetables as dietary sources of compounds with antioxidant and biological activity, *LWT-Food Sci Technol*, 55 (2014) 389-396.

5 Garcia-Herrera P, Morales P, Fernandez-Ruiz V, Sanchez-Mata MC, Camara M, Carvalho AM, Ferreira I CFR, Pardo-De-Santayana M, Molina M & Tardio J, Nutrients, phytochemicals and antioxidant activity in wild populations of *Allium ampeloprasum* L, a valuable underutilized vegetable, *Food Res Int,* 62 (2014) 272-279.

6 Turan M, Kordali S, Zengin H, Dursun A & Sezen Y, Macro and Micro Mineral Content of Some Wild Edible Leaves Consumed in Eastern Anatolia, *Acta Agric Scand Sect B*, 3 (2003) 129-137.

7 Gupta K, Barat GK, Wagle DS & Chawla HKL, Nutrient contents and anti-nutritional factors in conventional andnonconventional leafy vegetables, *Food Chem*, 31 (1989) 105-116.

8 Afolayan AJ & Jimoh FO, Nutritional quality of some wild leafy vegetables in South Africa, *Int J Food Sci Nutr*, 60 (2009) 424-431.

9 Burton GW & Traber MG, Vitamin E: antioxidant activity, biokinetics, and bioavailability, *Annu Rev Nutr,* 10 (1990) 357-382.

10 Saha D, Sundriyal M & Sundriyal RC, Diversity of food composition and nutritive analysis of edible wild plants in a multi-ethnic tribal land, Northeast India: an important facet for food supply, *Indian J Tradit Knowle,*13 (2014) 698-705.

11 Maroyi A & Mosina GKE, Medicinal plants and traditional practices in peri-urban domestic gardens of the Limpopo province, South Africa, *Indian J Tradit Knowle*, 13 (2014) 665-672.

12 Cakilcioglu U & Turkoglu I, An ethnobotanical survey of medicinal plants in Sivrice (Elazığ-Turkey), *J Ethnopharmacol*, 132 (2010) 165-175.

13 Polat R, Selvi S, Cakilcioglu U & Acar M, Investigations of ethnobotanical aspect of wild plants sold in Bingöl (Turkey) local markets, *Biol Divers Conserv,* 5 (2012) 155-161.

14 Dogan Y, Baslar S, Ay G & Mert HH. The use of wild edible plants in western and central Anatolia (Turkey), *Econ Bot,* 58 (2004), 684-690.

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

16 Uyar BB, Gezmen-Karadag M, Sanlier N & Gunyel S, Determination of total phenolic content of some plants, *Gıda*, 1 (2013) 23-29.

17 Yesil Y & Akalın E, The use of wild edible plants in Kurecik (Akçadağ/Malatya), *J Fac Pharm*, 41 (2010) 90-103.

18 Singleton VL & Rossi JA, Colorimetry of total phenolics with phosphomo- lybdic-phosphotungstic acid reagents, *Am J Enol Vitic,* 16 (1965) 144-158.

19 Slinkard K & Singleton VL, Total phenol analyses: automation and comparison with manual methods, *Am J Enol Vitic,* 28 (1977) 49-55.

20 Burits M & Bucar F, Antioxidant activity of *Nigella sativa* essential oil, *Phytother Res,* 14 (2000) 323-328.

21 Serteser A, Kargioglu M, Gok V, Bagci Y, Ozcan MM & Arslan D, Antioxidant properties of some plants growing wild in Turkey, *Grasas Y Aceites*, 60 (2009), 147-154.

22 Isbilir SS & Sagiroglu A. Total phenolic content, antiradical and antioxidant activities of wild and cultivated *Rumex acetosella* L. extracts, *Biol Agric Hortic,* 29 (2013) 219-226.

23 Wong JY, Matanjun P, Ooi YBH, Chia KF, Characterization of phenolic compounds, carotenoids, vitamins and antioxidant activities of selected Malaysian wild edible plants, *Int J Food Sci Nutr,* 64 (2013) 621-631.

24 Nuutila AM, Puupponen-Pimia R, Aarni M & Oksman Caldentey KM, Comparison of antioxidant activities of onion and garlic extracts by inhibition of lipid peroxidation and radical scavenging activity, *Food Chem,* 81 (2003) 485-493.

25 Bravo L, Polyphenols: chemistry, dietary sources, metabolism, and nutritional significance, *Nutr Rev,* 56 (1998) 317-333.

26 Biesalski HK, Aggett PJ, Anton R, Bernstein PS, Blumberg J & Heaney RP, Scientific substantiation of health claims: evidence-based nutrition, *Nutrition,* 27 (2011) S1-S20.