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ANTIOXIDANT AND NUTRITIONAL CHARACTERISTICS OF GARDEN CRESS (*Lepidium sativum*)

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Abstract. Garden cress (*Lepidium sativum*), a member of the Brassicaceae family, is an underutilised crop in Europe and Turkey. The dry matter content, crude protein, ascorbic acid, minerals (N, P, K, Ca, Mg, Na, Fe, B, Cu, Na, Zn, Mn), the total phenolic content and the total antioxidant capacity of two garden cress cultivars, Izmir and Dadas, were studied. The results of mineral element analysis of both cultivars revealed that they had a high P, K, Ca, Mg and Na content. Both cultivars studied appeared to have exceptionally high levels of protein when compared with common vegetables. The mean ascorbic acid content of Dadas and Izmir cultivars were 54 and 74 mg 100 g^{-1} f.w., respectively. The total phenolic content of the garden cress leaves varied from 0.573 (Dadas) to 0.774 (Izmir) mg GAE · g^{-1} fw and from 6.332 (Dadas) to 7.401 (Izmir) mg GAE · g^{-1} dw. Antioxidant activities by 2-diphenyl-1-picryhydrazyl (DPPH) free-radical-scavenging assays for EC_{50} were determined as 330.99 (Dadas) and 346.65 (Izmir) for fw, and 128.08 and 85.97 (Izmir) for dw, respectively. Based on the results of the experiment reported herein, they may serve as a potential dietary source of some mineral and natural phenolic antioxidants. Our results imply garden cress as potential source for alternative dietary supplements of minerals and natural phenolic antioxidants.

Key words: variety, antioxidant activity, phenolic content, minerals content

INTRODUCTION

Turkey is located on the border of two main gene centres, the Mediterranean and the Near East. Its location has fostered the growth of a variety of cultivated and indigenous

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horticultural crops. "It is estimated that over 100 fruit taxa and nearly 50 vegetable taxa are grown successfully in the country" [Ercisli 2004]. Modern agricultural technology and marketing have caused a reduction in the genetic diversity of plant species, especially in vegetables, worldwide. Indigenous plants are found mostly in the rural areas of Turkey, where the occurrence of exotic species is limited. These indigenous plants are valuable sources of vitamins and minerals. They also provide part of the nutrient requirements of the local communities [Sengul et al. 2011, Tosun et al. 2012].

Lepidium sativum L. is an annual, erect edible herb and a member of the Brassicaceae family [Diwakar et al. 2010]. Garden cress nowadays is more popular in terms of consumers and producers because of its peppery taste and having health promoting substances such as glucosinolates and sterols [Tuncay et al. 2011]. "Two types of garden cress are cultivated in Turkey. These are "plain garden cress" and "curled garden cress", which is well distinguished with its curly and partial leaves. While common cress is widespread throughout the country, the cultivation of curled cress is mostly localised in the eastern part of Turkey and has recently been registered as a new cultivar (Dadas)" [Sarikamis and Yanmaz 2010]. It is an indigenous vegetable in the eastern part of Turkey [Yanmaz et al. 2010].

Garden cress has been shown to have a wide range of positive physiological effects on human health. Various beneficial effects have been observed with the consumption of garden cress. The reduction of the incidence of diseases such as prostate cancer, cardiovascular diseases, and diabetes have been reported in previous studies and is generally attributed to secondary metabolites, such as phenolic compounds [Dannehl et al. 2012].

Most of the indigenous vegetables are edible, and they play an important role in diet, particularly in rural areas. Information on the chemical composition of these vegetables is limited. This study was therefore undertaken in order to obtain data on the moisture, crude protein, ascorbic acid, minerals (N, P, K, Ca, Mg, Na, Fe, B, Cu, Na, Zn, Mn), the total phenolic content and the total antioxidant capacity of two garden cress cultivar, where one of them is indigenous in the eastern part of Turkey.

MATERIALS AND METHODS

Plant materials, cultivation, harvest. In this study two garden cress cultivars Dadas and Izmir (curled and plain garden cress) cultivated in Turkey were used as the plant material. Dadas is a new registered cultivar that has curly leaves, toothed partially at the leaf edge, commonly grown in the eastern part of Turkey, while Izmir is a plain garden cress cultivar commonly grown in the country.

The seeds for both cultivars were sown in field conditions at the Ataturk University Faculty of Agriculture, Department of Horticulture, in early April 2011. Seeds were sown in nine rows for each cultivar. Therefore, three rows were considered as a replicate. Routine cultural applications such as irrigation were followed.

Leaves were harvested at the optimum harvest time of 40 days after sowing. Leaves were harvested by hand and brought to the laboratory for phytochemical analyses. Samples were frozen immediately and then stored in approximately 100 g batches at -30°C prior to analyses.

Determination of dry matter (%), crude protein (%) and ascorbic acid (mg 100 g^{-1} f.w.) in garden cress leaves. For both cultivars, a total of 10 plants were thawed at room temperature and homogenised in a standard food blender. Homogenates were assayed for ascorbic acid (mg 100 g^{-1}). Crude protein (%) and dry matter (%) were determined by AOAC [1984]. The Kjeldahl method [Bremner 1996] and a Vapodest 10 Rapid Kjeldahl Distillation Unit (Gerhardt, Konigswinter, Germany) were used to determine total N content. Ascorbic acid of samples was quantified with a Merck reflectometer set (Merck RQflex).

Determination of total phenolics and antioxidant activity. Homogenates obtained with a blender were extracted with acetone, water, and acetic acid (70:29.5:0.5, v/v/v) for 1 hour in darkness [Singleton and Rossi 1965]. 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 [1977]. Gallic acid was used as the standard, and results were expressed as mg gallic acid equivalents per 100 g of fresh weight basis. The total antioxidant capacity of samples was determined by 2,2-Di phenyl-1-picrylhydrazyl radical (DPPH•) assays.

In the DPPH assay, 50 μL 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 read against a blank at 517 nm. DPPH in per cent (%) was calculated as follows: DPPH% = (Ablank-Asample/Ablank) × 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. EC50 is the effective concentration in μg extract/mL (μg extract for EC50 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 (EC50) [Burits and Bucar 2000].

Determination of mineral elements. Samples were oven-dried at 68°C for 48 hours and ground to pass a 1-mm sieve. Macro- (P, S, K, Ca, Mg and Na) and micro-elements (Fe, Mn, Zn, Cu, B, Ni and Mo) were determined after wet digestion of dried and ground subsamples using a HNO3-H2O2 acid mixture (2:3 v/v) with three steps (the first step: 145ºC, 75%RF, 5 minutes; the second step: 180ºC, 90%RF, 10 minutes and the third step: 100ºC, 40%RF, 10 minutes) in a microwave (Bergof Speedwave Microwave Digestion Equipment MWS-2) [Mertens 2005a]. Tissue P, K, S, Ca, Mg, Na, Fe, Mn, Zn, Cu and B were determined using an Inductively Coupled Plasma spectrophotometer (Perkin-Elmer, Optima 2100 DV, ICP/OES, Shelton, CT 06484-4794, USA) [Mertens 2005b].

All analyses were repeated five times, and standard errors were determined.

RESULTS AND DISCUSSION

Mineral element contents of garden cress cultivars. The values of minerals, which are important for human nutrition, are presented in Table 1. Significant differences were found between cultivars for all of the minerals (tab. 1). The cultivar Izmir had greater values of minerals than the Dadas, with the exception of B, Mn and Fe. When compared to several cultivated vegetables (Lettuce, Spinach, Parsley, and Cabbage), both cultivars had higher P, K, Ca, Na and Mg contents (tabs 1 and 2).

Macro and micro nutrient elements can play an important role in many metabolic processes and functions throughout the life cycle. Previous studies have proved that optimal dietary K, Mg, Ca, Mn, etc. intake cause lower blood pressure and protection from the risk of stroke and cardiovascular diseases [Splittstoesser 1990, Williams 1993]. The high P, K, Ca, Mg and Na content of the garden cress cultivars studied suggests that these cultivars could be used to meet the daily requirements of an adult.

Table 1. Mineral content of garden cress cultivars (n = 10)

Minerals	Dadas	Izmir
N (%)	1.14 ±0.21	1.43 ±0.15
P ($mg \cdot kg^{-1}$)	1478 ±56	1729 ±124
K ($mg \cdot kg^{-1}$)	7192 ±225	8434 ±161
Ca ($mg \cdot kg^{-1}$)	2773 ±265	3410 ±98
Mg ($mg \cdot kg^{-1}$)	6857 ±65	7804 ±137
S ($mg \cdot kg^{-1}$)	4651 ±120	4745 ±42
Fe ($mg \cdot kg^{-1}$)	47.21 ±2	45.94 ±6.4
Mn ($mg \cdot kg^{-1}$)	74.20 ±8.4	62.01 ±2.7
Mo ($mg \cdot kg^{-1}$)	10.69 ±3.5	16.59 ±2.8
Na ($mg \cdot kg^{-1}$)	749 ±55	922 ±64
B ($mg \cdot kg^{-1}$)	11.70 ±2.5	7.89 ±3.2
Ni ($mg \cdot kg^{-1}$)	3.30 ±1.6	3.70 ±0.4
Zn ($mg \cdot kg^{-1}$)	92.30 ±9.5	118.80 ±5.5
Cu ($mg \cdot kg^{-1}$)	26.16 ±2.4	28.33 ±1.8

Table 2. The protein ($g\ 100\ g^{-1}$), mineral ($mg\ kg^{-1}$) and ascorbic acid contents ($mg\ 100\ g^{-1}$) of some selected cultivated vegetables [Lorenz and Maynhart 1980, McCollum 1992]

Species	Protein	P	K	Ca	Fe	Na	Mg	Ascorbic acid
Lettuce	1.6	250	2640	680	14	90	110	180
Spinach	2.9	510	4700	930	31	710	660	510
Parsley	2.2	630	7270	2190	62	450	140	1720
Cabbage	1.2	290	2330	490	4.0	200	210	470

Both cultivars studied appeared to have exceptionally high levels of protein when compared with the common vegetables (spinach, cabbage, parsley and lettuce) presented in Table 2 [Lorenz and Maynhart 1980, McCollum 1992]. The dry matter ratio values of garden cress cultivars ranged from 9.05 to 10.46% (tab. 3). The mean ascorbic acid content of cultivars was 54 and 74 mg 100 g^{-1}, which were higher than those of lettuce, spinach and cabbage (tabs 2 and 3).

Table 3. The dry matter, crude protein, ascorbic acid, Total Phenolic Content (TPC) and free radical scavenging capacity (DPPH) of dry (DW) or fresh (FW) garden cress cultivars

Cultivar	Dry matter %	Crude protein %	Ascorbic acid mg 100 g^{-1}	Total phenolic content (TPC)		EC50	
				mg GAE·g^{-1} FW	mg GAE·g^{-1} DW	FW	DW
Dadas	9.05 ±0.04	7.13 ±0.04	54 ±2.23	0.573 ±0.02	6.332 ±0.21	330.99 ±21.8	128.08 ±21.1
Izmir	10.46 ±0.05	8.94 ±0.94	74 ±6.45	0.774 ±0.03	7.401 ±0.43	346.65 ±42.3	85.97 ±17.5

Previous studies have reported the dry matter ratio and ascorbic acid values for garden cress leaves as 10.63% and 91.4 mg 100 g^{-1}, respectively [Oz 201]. The variation in the dry matter ratio, ascorbic acid, pH and crude proteins of garden cress leaves can be affected by various factors such as cultivars, climatic conditions, cultural practices, maturity at harvest and storage conditions [Podsędek 2007, Tuncay et al. 2011].

Total phenolics and antioxidant activity of garden cress cultivars. The total phenolic content of the garden cress leaves varied from 0.573 (Dadas) to 0.774 (Izmir) mg GAE/g fw and from 6.332 (Dadas) to 7.401 (Izmir) mg GAE/g dw (tab. 3). In this study, garden cress cultivars were studied in fresh and dried forms. Both garden cress cultivars had almost same values on dry basis. Furthermore, cultivar Izmir showed higher phenolic content than Dadas. Podsędek [2007] has reported that the phenolic content of Brassica vegetables ranged from 15 mg/100 g fw in white cabbage to 337.0 mg/100 g f.w. in broccoli.

The DPPH scavenging capacities of the garden cress cultivars is presented in Table 3. Antioxidant activities by 2-diphenyl-1- picryhydrazyl (DPPH) free-radical-scavenging assays for EC50 were determined as 330.99 (Dadas) and 346.65 (Izmir) for fw, and 128.08 and 85.97 (Izmir) for dw, respectively. The DPPH scavenging capacity of fresh leaves of Dadas for EC50 was higher than that of Izmir. However, in dry leaves Izmir had a higher capacity than Dadas. Furthermore, dry forms of both cultivars had higher DPPH scavenging capacity. Oz [2011] determined that DPPH scavenging capacity of a garden cress cultivar as EC50 was 233.475 mg/ml. Both genotype and growing conditions may alter the antioxidant composition and properties of a selected agricultural crop. For instance, the highest day/night temperature ratio has found to result in the highest phenolic content and the strongest antioxidant activity [Wang and Zheng 2001].

The present study demonstrated that garden cress may serve as a potential dietary source of some mineral and natural phenolic antioxidants. Our results are concordant with previous reports that brassica group vegetables are effective antioxidants [Podsędek 2007, Sengul et al. 2011]. Some foods and vegetables are important sources of exogenous antioxidants. In fact, Brassica crops are among those vegetables that have the highest antioxidant activity [Soengas et al. 2012]. Antioxidants can help to maintain the oxidant-antioxidant balance and inhibit the damage caused by reactive oxygen species.

In conclusion, garden cress cultivars can be very important source of ascorbic acid, protein, mineral elements, antioxidants and phenolics. There are many choices of vegetable sources, although today many of these are neglected because of the preference towards uniform characteristics in modern agricultural technology and marketing. Therefore, it is of importance to determine phytochemical properties of the plants locally consumed as indigenous vegetables. Our study provides an alternative source of antioxidants along with other dietary supplements in form of commonly cultivated Garden Cress

REFERENCES

AOAC, 1984. Officials methods of analysis (14th ed.). Association of Official Analytical Chemist, Arlington, USA.

Bremner J.M., 1996. Nitrogen-total. In: Methods of soil analysis part 3: chemical methods, Bartels J.M., Bigham J.M. (eds.). SSSA-ASAgronomy, Madison, Wisconsin, 1085–1121.

Burits M., Bucar F., 2000. Antioxidant activity of Nigella sativa essential oil. Phytother. Res. 14, 323–328.

Dannehl D., Huyskens-Keil S., Wendorf D., Ulrichs C., Schmidt U., 2012. Influence of intermittent-direct-electric-current (IDC) on phytochemical compounds in garden cress during growth. Food Chem., 131, 239–246.

Diwakar B.T., Dutta P.K.. Lokesh B.R., Naidu K.A., 2010. Physicochemical properties of garden cress (*Lepidium sativum* L.) Seed Oil, AOCS 87, 539–548.

Ercisli S., 2004. A short review of the fruit germplasm resources of Turkey. Genet. Res. Crop Evol. 51, 419–435.

Lorenz O.A, Maynhart D.N., 1980. Knott's handbook for vegetable growers. New York, John Wiley, USA.

McCollum J.P., 1992. Vegetable vrops. Danville, Interstate Publ. Inc. USA.

Mertens D., 2005a. AOAC Official Method 922.02. Plants Preparation of Laboratuary Sample. Official Methods of Analysis, 18th edn. Horwitz W., G.W. Latimer (eds). Chapter 3, pp1-2, AOAC-International Suite 500, 481. North Frederick Avenue, Gaitherburg, Maryland, USA.

Mertens D., 2005b. AOAC Official Method 975.03. Metal in Plants and Pet Foods. Official Methods of Analysis, 18th edn. Horwitz W., G.W. Latimer (eds). Chapter 3, pp 3–4, AOAC-International Suite 500, 481. North Frederick Avenue, Gaitherburg, Maryland, USA.

Oz O., 2011. Effects of storage on composition of some vegetables of boiled and drying. Master Thesis. Ataturk University, Graduate School of Natural and Applied Science.

Podsędek A., 2007. Natural antioxidants and antioxidant capacity of Brassica vegetables: A review. LWT 40, 1.

Sarikamis G., Yanmaz R., 2011. Effects of cultivar and developmental stage on glucosinolates in garden cress (*Lepidium sativum* L.). J. Med. Plant. Res. 5(17), 4388–4392.

Sengul M., Yildiz H., Ercisli S., Yildirim E., Turan M., Ozdemir O., Sener, D., 2011. Some phytochemical characteristics of turnip (*Brassica rapa* var. rapa L.) roots. Ital. J. Food Sci. 23(3), 338–343.

Singleton V.L., Rossi J.A., 1965. Colorimetry of total phenolics with phosphomolybdic–phosphotungstic acid reagents. Am. J. Enol. Viticul. 16, 144–158.
Slinkard K., Singleton V.L., 1977. Total phenol analyses: automation and comparison with manual methods. Am. J. Enol. Vitic. 28, 49–55.
Soengas P., Cartea M.E., Francisco M., Sotelo T., Velasco P., 2012. New insights into the antioxidant activity of Brassica crops. Food Chem. 134, 725–733.
Splittstoesser W.E., 1990. Vegetable growing handbook. Westport, Avi Publ. Co. Inc., USA.
Tosun M., Ercisli S., Ozer H., Turan M., Polat T., Ozturk E., Padem H., Kilicgun H., 2012. Chemical composition and antioxidant activity of foxtail lily (*Eremurus spectabilis*). Acta Sci. Pol., Hortorum Cultus 11(3), 145–153.
Tuncay O., Esiyok D., Yagmur B., Okur B., 2011. Yield and quality of garden cress affected by different nitrogen sources and growing period. Afr. J. Agric. Res. 6(3), 608–617.
Wang S.Y., Zheng W., 2001. Effect of plant growth temperature on the antioxidant capacity in strawberries. J. Agric. Food Chem. 49, 4977.
Williams D.E., 1993. Lycianthes moziniana (*Solanaceae*): an underutilized Mexican food plant with ‘new’ crop potential. Econ Bot. 47(4), 387–400.
Yanmaz R., Yildirim E., Koyuncu D., 2010. A New Garden Cress (*Lepidium sativum* var. sativum) variety for Turkey: Dadas. J. Agric. Fac. Ataturk Uni. 41(2), 91–95.

ANTYOKSYDACYJNE I ODŻYWCZE WŁAŚCIWOŚCI RZEŻUCHY (*Lepidium sativum*)

Streszczenie. Rzeżucha (*Lepidium sativum*), należąca do rodziny Brassicaceae jest mało użytkowaną rośliną w Europie i Turcji. Badano zawartość suchej masy, surowego białka, kwasu askorbinowego, składników mineralnych (N, P, K, Ca, Mg, Na, Fe, B, Cu, Na, Zn, Mn), całkowitą zawartość związków fenolowych oraz ogólne właściwości antyoksydacyjne dwóch odmian ogrodowych, Izmir i Dadas. Wyniki analizy pierwiastków mineralnych ukazały, że odmiany te mają wysoką zawartość P, K, Ca, Mg i Na. Okazało się, że obie odmiany mają wyjątkowo wysoki poziom białka w porównaniu z popularnymi warzywami. Średnia zawartość kwasu askorbinowego w liściach rzeżuchy ogrodowej wynosiła 54 (Dadas) i 74 (Izmir) mg 100 g^{-1} św.m. Całkowita zawartość fenoli w liściach rzeżuchy wahała się między 0,573 (Dadas) a 0,774 (Izmir) mg GAE · g^{-1} św.m. oraz od 6,332 (Dadas) do 7,401 (Izmir) mg GAE · g^{-1} s.m. Aktywność antyoksydacyjną, oznaczoną według metody DPPH dla EC_{50}, ustalono odpowiednio na 330,99 (Dadas) oraz 346,65 (Izmir) dla św.m., a 128,08 i 85,97 (Izmir) dla s.m. Niniejsze wyniki dowodzą, że niektóre fenolowe antyoksydanty mogą służyć jako potencjalne składniki żywieniowe.. Nasze wyniki wskazują rzeżuchę ogrodową jako źródło alternatywnych suplementów składników mineralnych i naturalnych antyoksydantów fenolowych.

Słowa kluczowe: odmiana, aktywność antyoksydacyjna, zawartość fenoli, zawartość składników mineralnych

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