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Determination of Antioxidant and Phenolic Content of Edible Plants

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Abstract

Today, there is a growing interest in nutritional awareness and a selective preference towards a healthy and balanced diet. A number of varieties of vegetables are good sources of essential components in human nutrition, providing vitamins, minerals, and fibre in general. Furthermore, chemical substances specific for given vegetables are responsible for various effects in the living organisms. For instance, natural antioxidants are the commonly known components of vegetables, neutralizing free radicals in the human body. The aim of the research was to evaluate antioxidant activity and phenolic content in leaves of three common Urtica dioca L., Rumex acetosella L., and Chenopodium album L. The antioxidan activity of these plants varied from 117.99 to 1273.83 µMTE/g. Urtica dioica L. had the highest antioxidan activity (1273.83 µMTE/g) followed by Rumex scutatus L.(225.09 µMTE/g) while the lowest value was observed in Chenopodium album L.(117.99 µMTE/g). The highest phenolic compound was determined in Urtica dioica L.(0.811 mMGAE/g), and the lowest phenolic compound was found in Rumex scutatus L. (0.481 mMGAE/g). The results obtained in this study indicate that wild Urtica dioca L., Rumex acetosella L., and Chenopodium album L. could be an important dietary source because of its good antioxidant and phenolic content properties.

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INTRODUCTION

Several epidemiological studies are available in the literature investigating the association between the consumption of plants, fruits and vegetables, reporting that an increased consumption of fruits and vegetables correlates with improved health outcomes. It is reported that the increased consumption of plants reduces the risk of developing several diseases including cardiovascular diseases, cancer, stroke, degenerative diseases, as well as, providing a reduction in the risk of functionality loss emerging with increasing age (Everitt *et al*.,2006). Besides the vitamin and mineral-rich content, fruits and vegetables have received considerable attention for the phenolic components and flavonoids in their content(Pandev and Rizvi, 2009). These latter compounds have become the focus of research primarily because of their health- promoting effects, including but not limited to their antioxidant and anti-inflammatory activities. It is suggested in the literature that the health benefits of the plants are associated with the interactions between the phenolic compounds and several key molecules, functions or pathways in the body such as enzymes, signalling cascades, cytokines, regulatory transcription factors, and antioxidant systems(Espinosa-Diez el al.,2015).

There are more than 1000 plant species of Urticaceae or the nettle family. U. *dioica* L., commonly known as the stinging nettle around the World, has already been used as a folklore remedy for a wide spectrum of diseases. The leaves and roots of the plant are traditionally used in many cultures as a blood purifier or diuretic. In Turkish folk medicine, *U. dioica* L. is used for the alleviation of the stomach ache. The infusion of the stinging nettle is assumed to provide beneficial effects against the common cold, cough, nasal or menstrual haemorrhages, diabetes, rheumatic symptoms, eczema, anaemia, hair loss, and diarrhoea. The putative hypotensive, anti- inflammatory, and immunomodulatory effects and those effects in prostatic hyperplasia or liver insufficiency have also been reported with the use of the stinging nettle. It was reported that *U. dioica L.* prevented the development of injury in the rat liver. Furthermore, it was suggested that it served as an adjuvant treatment for rheumatoid arthritis. It was also suggested that the extracts of *U. dioica L.* leaves or seeds were beneficial in the functional deficiencies of neutrophils.

Rumex acetosella L.(Polygonaceae) or 'sheep sorrel' is a common perennial plant development in silage fields, on river banks, in ditches, and on waste grounds. It has long been used in folklore medicine as an antidote to nettle, in the treatment of sores, blisters, and burns, and eveni n cancer and tumours. Its traditional use for depurative, astringent, laxative, and tonic purposes has also been reported(Duke, 1999). It is reported in the literature that anthracene derivatives, flavonoids, procyanidins, and oxalic acid were found in the components of this plant(Trichopoulou et al., 2000; Spencer et al., 2007; Wegiera et al., 2007).

Chenopodium album L. (Chenopodiaceae) has long been known as a leaf vegetable. Besides the use of the leaves, young sprouts, and the seeds of *Chenopodium album L.* as food, Chenopodium species have also received attention because of their suggested effects in the folk medicine, including their use as an anthelmintic, stomachic, antispasmodic, diaphoretic, emmenagogue, and abortifacient traditional remedy. They are also assumed to provide relief against menstrual pain, amenorrhea, asthma, catarrh, and migraine (Ahmed et al.,2017).

Due to its high value medicinal usage, the present study was performed to investigate free radical scavenging activity, total phenolic content of the herbs.

Methodology

Collection of Plant Materials

The three wild edible plant species used as experimental material (*Urtica urens* L., *Rumex scutatus* L., and *Chenopodium album* L.) were collected from various grasslands of Erzurum province, located in the Eastern Anatolia Region of Turkey (Table 1), in June 2017 at optimum growth stage of the plants for consumption. The taxonomic identifications of the plants were made according to Davis et al.(1988). The plants were separated as the edible and the discarded parts. A dried sample (10 g) was chopped into small pieces using a blender. Ethanol extraction was followed by filtration and evaporation of the filtrate to dryness at 30^{O}C in the rotary vacuum evaporator. In all cases, three independent experiments, each with duplicate measurements, were performed. The results shown are the means of these measurements.

Antioxidant Activity Evaluation

The 2,2-diphenyl-1-picrylhydrayl (DPPH) Free Radical Scavenging Assay

The antioxidant activity of the plants was evaluated by the 2,2-diphenyl-picrylhydrayl (DDPH) free radical scavenging assay, previously implemented (Scherer 2009). Absorbance at 515 nm was measured in a visible light spectrophotometer. Methanol (HPLC-grade) was used as a blank, and trolox(6-hydroxy-2,5, 7,8-tetramethylchroman-2-carboxylic acid, Sigma) was used for the standard curve. Antioxidant activity was expressed as µg of trolox equivalents per 1 mL of extracts (µg trolox equiv./g DE)(Julia et al., 2018).

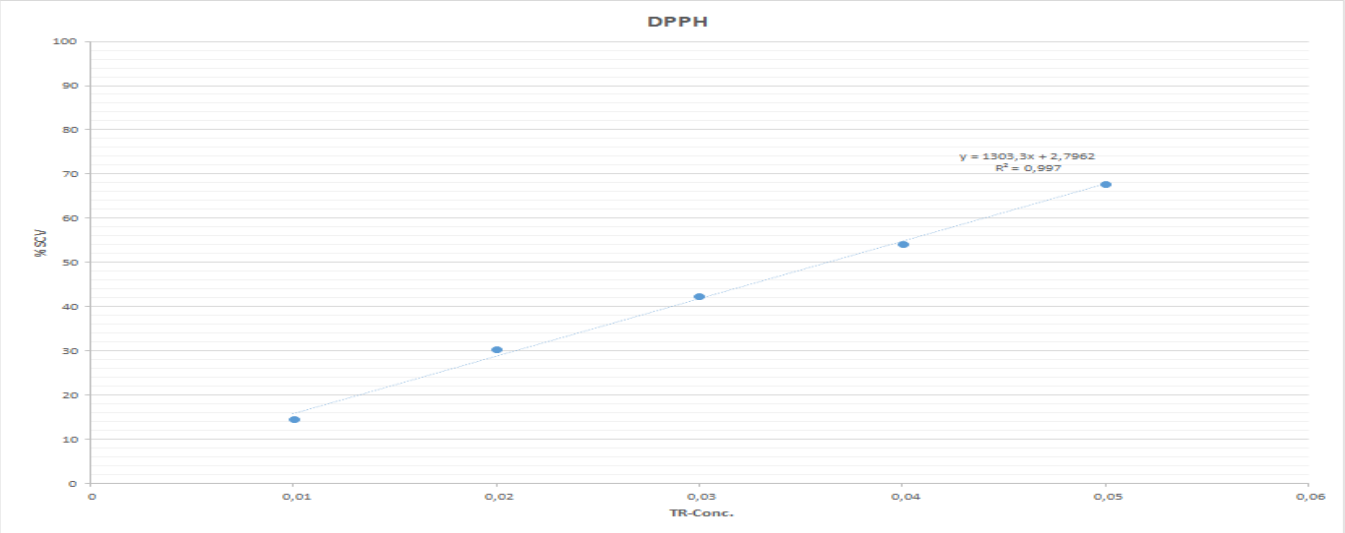
Total Phenolic Content: Total phenolic compound contents were determined by the Folin Ciocalteau method (Blainski et al., 2013). The extract samples were mixed with Folin Ciocalteu reagent. The mixture was allowed to stand for 15 min and the phenols were determined by colorimetric method at 765 nm. The standard curve was prepared using the standard solution of gallic acid in methanol in the range 20-200µg/ml.(Asadi et al., 2010).

Finding

Natural products have always been a prefered choice of all as it plays a great role in discovering new medicines. There are many organic compounds which are capable of acting as antioxidants. Many natural substances with an antioxidant effect can protect particularly unsaturated fatty acids against oxidative damage, the process being a crucial step in the development of coronary heart diseases such as stroke and heart attack. The antioxidant compounds from food participate in the removal of reactive oxygen speice that is why a balanced diet rich in natural phenols and other antioxidants is required for the prevention of some lifestyle diseases. Furthermore, natural polyphenols have neuroprotective ability and maintain normal cognitive function in the process of brain ageing.

Antioxidant activity (DPPH) results were given in Table 1. Standard curve is shown in Figure 1.

Figure 1. Trolox standard graphic for antioxidant activity(DPPH)



Gallic acid standard curve was used to calculate total phenol contents(Fig 2) and total phenolic content of the samples defined as mMGAE/g(Table 1).

Figure 2. Standard graphic prepared with gallic acid for total phenol content

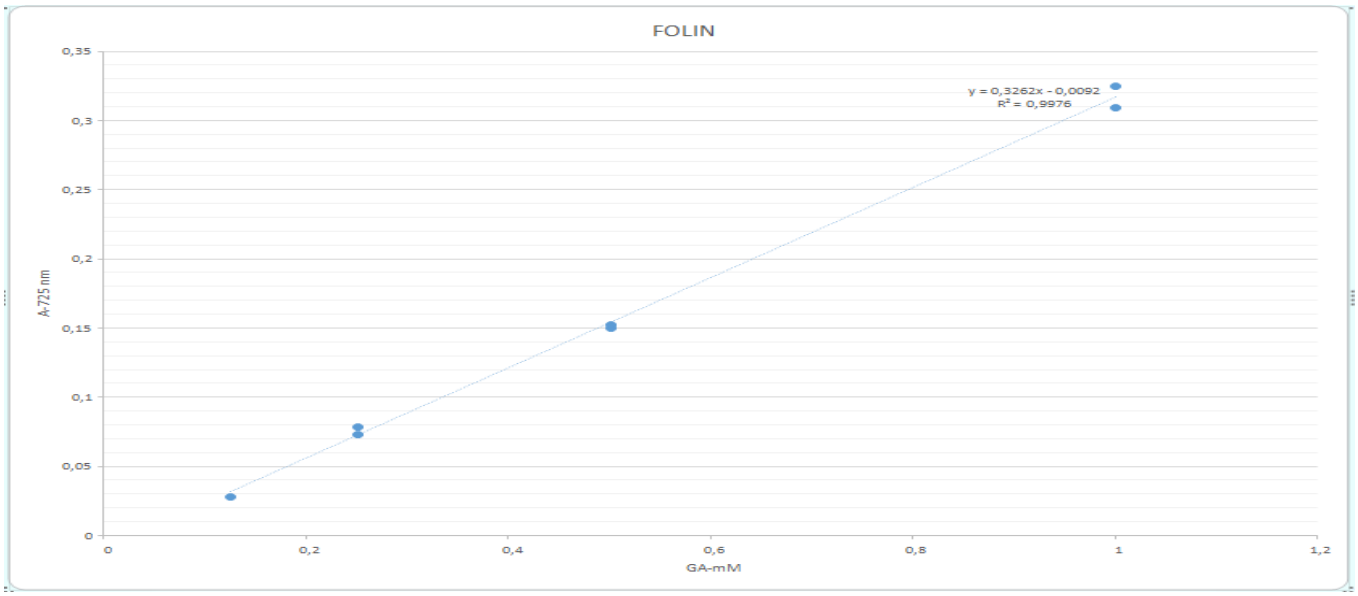


Table 1. Antioxidant activity and total phenolic compounds of plant extracts

Plant extracts	**Antioxidant activity(DPPH)µMTE/g**	**Total Phenolic Content(Folin) mMGAE/g**
Urtica dioica L.(ETOH)	1273.83	0.811
Rumex scutatus L. (ETOH)	225.09	0.481
Chenopodium album L.(ETOH)	117.99	0.647

Urtica dioica L., *Rumex scutatus* L. and *Chenopodium album* L. well-known and abundantly used species (Guler 2004.). These wild edible plant species were screened for their antioxidan activity and phenolic compound (Table 1).

The antioxidan activity of these plants varied from 117.99 to 1273.83 µMTE/g. *Urtica dioica*

L. had the highest antioxidan activity followed by *Rumex scutatus* L. while the lowest value was observed in *Chenopodium album* L..

The highest phenolic compound was determined in *Urtica dioica* L.(0.811 mMGAE/g), and the lowest phenolic compound was found in *Rumex scutatus* L. (0.481 mMGAE/g). Our findings were similar to the findings of other researchers for *Chenopodium album* L. (Ahmed et al., 2017, Gohar et al., 2000). An other study, the highest phenolic contents were found in a *Rumex scutatus* L. ethanol extracts(Isbilir, 2008). A study compared the 2,2-diphenyl-1-picrylhydrazyl (DPPH) scavenging capacity of the extracts of this plant with Trolox, a well- known antioxidant. The study demonstrated that the antioxidant properties of *Rumex scutatus*

L. occurred owing to the medium polarity compounds in the plant. The other compounds in the plant, including the anthracene derivatives, flavonoids, procyanidins, and oxalic acid might have also contributed to the antioxidant activity of this plant. Most of these compounds are polyphenolic compounds, demonstrating such activities owing to the presence of phenolic hydroxyl groups in their structures(Trichopoulou et al.,2000; Spencer et al., 2007; Wegiera et al,,2007).

Results for total phenolics in *Chenopodium album* L. and *Urtica dioica* L. are consistent to the data obtained by Afolayan and Jimoh (2009) using the same procedures. Both these species had relatively high phenolics contents. A vegetables of *Urtica dioica* L., *Rumex scutatus* L. and *Chenopodium album* L. can be a potent source of valuable phenolic antioxidants.

The antioxidant activities of wild plants are usually higher compared to the common vegetables (Kwinana-Mandindi, 2015). Nijveldt et al.(2001) also showed that the flavonoids and other phenolic compounds in wild and common vegetables were higher than their exotic counterparts.

Reviewing the antioxidant activities, occurrences, and latent uses of phenolic compounds in plants and agri-industrial by-products, Balasundram et al., (2006) reported that fruits, vegetables, and beverages were the main sources of phenolic compounds in the human diet.

The polyphenols in the plants are dietary antioxidants in the human diet, offering some protection against oxidative damage. The phenolic compounds are the natural antioxidantsand they are rich in fruits, vegetables, and plant-based beverages. In the literature, it was reported that, among the dietary antioxidants, they were the most abundant compounds in the human diet. The significant focus on the phenolic compounds is mainly due to their antioxidant properties, suggested to play a critical role in providing health benefits for humans.

Polyphenols, especially flavonoids, phenolic acids, and tannins inhibit glucosidase and amylase, which are the key enzymes in the metabolism for the digestion of dietary carbohydrates to glucose.

It should be remembered that the composition of biologically active compounds in plants, therefore in vegetables, depends on a number factors including the climate and growing conditions, cultivar properties, plant growth and development stages, and harvesting time. Antioxidant content also can vary among individual plants of the same species. Stress conditions during plant growth and development increase the content of antioxidants in plants. Climate

and soil, agrotechnological factors, place and date of planting, fertilizing, mulching, salinity are the putative stress factors suggested playing a role in determining the of antioxidant content in plants.

Conclusion

The health benefits of wild edible plants have been known for a long time. This study has shown that some of the wild edible vegetables are good sources of antioxidants in regards to their total phenolic content. The antioxidant activity of *Urtica* species, which are being consumed as food already (green leaves), was higher compared to other wild vegetables analyzed.

The selective use of unusual species of plants, including *Urtica dioica* L., *Rumex scutatus* L., and *Chenopodium album* L., as food can enrich our everyday diet with the antioxidants in their contents. In this study obtained with the data, the biological activity of these plants was revealed. In this respect, the study contributed to the literature and it is thought that it could lead to further studies.

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