Turkish Journal of Agriculture - Food Science and Technology, 7(10): 1561-1567, 2019
DOI: https://doi.org/10.24925/turjaf.v7i10.1561-1567.2583

Turkish Journal of Agriculture - Food Science and Technology

Available online, ISSN: 2148-127X | www.agrifoodscience.com | Turkish Science and Technology

Antioxidant Activity of *Allium scorodoprasum* L. *subsp. rotundum* (L.) STEARN Plant Grown in Turkey

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ARTICLE INFO

Research Article

Received : 03/04/2019
Accepted : 11/09/2019

Keywords:
Allicin
Allium
Antioxidant activity
Total phenolics
Körmen

ABSTRACT

Allium scorodoprasum L. subsp. *rotundum* (L.) STEARN is a medical and aromatic plant which grows naturally in various countries of the world. The purpose of this study was to determine the natural antioxidant content and antioxidant activity of *Allium scorodoprasum* L. subsp. *rotundum* (L.) STEARN plant, an *Allium* subspecies of the *Alliaceae* family. Plants which grow naturally in 7 different locations of 3 cities (Samsun, Nevşehir and Tokat) of Turkey were used in the study. The purpose of this study was to determine the natural antioxidant content and antioxidant capacity of wild leek plant, an *Allium* subspecies of the *Alliaceae* family, which grows in three different cities (Samsun, Nevşehir and Tokat). The material of the study consists of 42 wild leek samples from 7 different locations of Samsun, Tokat and Nevşehir. Some physicochemical characteristics and antioxidant features of both bulbs and leaves of samples were determined separately; allicin, an organosulfur compound, was specified qualitatively and thermal behaviours of the samples were monitored through TGA/DSC analysis. As a result of the analyses conducted, in the bulb and leaf parts of the samples, total phenolic matter values were 254.51-927.81 and 1929.05-19645.24 mg/kg, FRAP was 0.80-5.20 and 14.31-47.83 mM TE/g, DPPH free radical scavenger effect was 0.99-9.02 and 36.61-241.06 µmol TE/g and ascorbic acid content was 29.14-314.01 mg/kg and 200.64-1383.16 mg/kg, respectively. These data reveal that the leaf's of *A. scorodoprasum* subsp. *rotundum* plants are rich in antioxidants. In conclusion, it was found that the antioxidant activity of the plants differs significantly in terms of the parts of the plant and growth location.

Türk Tarım – Gıda Bilim ve Teknoloji Dergisi 7(10): 1561-1567, 2019

Allium scorodoprasum L. subsp. *Rotundum* (L.) STEARN Bitkisinin Antioksidan Özelliklerinin Tayini

MAKALE BİLGİSİ

Araştırma Makalesi

Geliş : 03/04/2019
Kabul : 11/09/2019

Anahtar Kelimeler:
Allisin
Allium
Antioksidan aktivite
Toplam fenol
Körmen

ÖZ

Allium scorodoprasum L. subsp. rotundum (L.) STEARN bitkisi dünyanın çeşitli ülkelerinde doğal olarak yetişen tıbbi ve aromatik nitelikte bir bitkidir. Bu çalışma Alliaceae familyasının Allium cinsine ait 3 farklı ilde (Samsun, Nevşehir ve Tokat) yetişen körmen bitkisinin doğal antioksidan içeriğini ve antioksidan kapasitesini belirlemek amacıyla yapılmıştır. Araştırma materyalini Samsun, Tokat ve Nevşehir'in 7 farklı lokasyonundan sağlanan 42 körmen örneği oluşturmaktadır. (Çalışmada 3 ilde 7 farklı lokasyonda doğal olarak yetişen bitkiler kullanılmıştır.) Örneklerin hem soğan hem de yaprak kısımlarında ayrı ayrı bazı fizikokimyasal özellikler ve antioksidan özellikler belirlenip, organosülfür bileşiklerinden allisinin kalitatif olarak tayini yapılmış ve TGA/DSC analiziyle örneklerin termal davranışları izlenmiştir. Yapılan analizler sonucunda, örneklerin soğan ve yaprak kısımlarının toplam fenolik madde değerleri sırasıyla, 254,51-927,81 ve 1929,05-19645,24 mg/kg, FRAP 0,80-5,20 ve 14,31-47,83 mM TE/g, DPPH serbest radikal temizleme etkisi 0,99-9,02 ve 36,61-241,06 µmol TE/g, askorbik asit içeriği ise 29,14-314,01 mg/kg ve 200,64-1383,16 mg/kg olarak belirlenmiştir. Bu veriler A. scorodoprasum subsp. rotundum bitkisinin yapraklarının antioksidanlar bakımından zengin olduğunu ortaya koymaktadır. Sonuç olarak, bitkilerin antioksidan aktivitesinin, bitkinin kısımları ve bitkinin yetiştiği bölge koşulları açısından önemli ölçüde farklı olduğu bulunmuştur.

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Introduction

Since ancient times, people have developed medicines for the treatment of diseases. They used natural products such as plants, fungi, animals, microorganisms and marine organisms to prepare these drugs (Sevindik et al., 2017; Pehlivan and Sevindik, 2018). *A. scorodoprasum* subsp. *rotundum*, a subspecies of the *Alliaceae* family, is a medical and aromatic plant which grows naturally in various countries of the world, including our country. *A. rotundum* belongs to *Allium* species. *Allium* species is the widest and the most characteristic member of *Alliaceae* family, which includes more than 800 species, 15 subspecies and 72 sections (Fritsch et al., 2010; Miryeganeh and Movafeghi, 2009). The members of this species are consumed since the old ages because of their taste and aroma ingredients. While a great number of its species are preferred widely in folk medicine, this plant which has economical value is also used as herbal medicine and decorative plant. These plants are generally bulbous and perennial (Zouari et al., 2013; Mitic et al., 2014). They have a wide distribution in the world, especially in the northern hemisphere (Mehrabi and Nasab, 2012). *Allium* plants are rich in terms of thiosulphate and organosulphur compounds which play an important role in cell biochemistry (Sahu, 2002). These plants protect against a great number of diseases such as cancer, obesity, cardiovascular diseases, diabetes, hypercholesterolemia and hypertension (Lanzotti, 2006; Pardo et al., 2007).

A. rotundum, which has medical properties, is known as wild leek in the world (Mehrabi and Nasab, 2012). Studies in literature about *A. rotundum*, which is consumed due to its health effects besides its use as food in public, are limited. The purpose of this study was to determine the natural antioxidant content and antioxidant activity of *A. scorodoprasum* subsp. *rotundum* plant and to determine the presence of allicin, which is one of the organosulphur compounds.

Material and Methods

Sample Collection and Identification

Plant materials were collected in April till June (2015) from different regions of Turkey. The plants were collected from 7 different locations in 3 different cities as Samsun (latitude 41° 21′ 3.3732"N X 36° 9′ 58.2336"W**,** 300-700 m above sea level), Nevşehir (latitude 38° 38′ 55.5000" N X 34° 50′ 10.3236", 800-1100 m above sea level) and Tokat (latitude 40° 32′ 59.9964"N X 37° 10′ 0.0048" W, 1300-1700 m above sea level). The plants were identified at Ondokuzmayıs University, Faculty of Science and Arts, Department of Botanic at the Department of Biology. After the plants taken to the laboratory were washed and the extra water was removed, bulbs and fresh leaves were prepared separately for analysis.

Preparation of Extracts for Antioxidant Activity

Antioxidant compounds were extracted with aqueous methanol (80%) using ultrasonic bath (Bandelin, Berlin, Germany) for 20 min at room temperature. The extracts was filtered through 0.45 µm teflon filter.

Colour Analysis

The colour of the plants was measured using a chromameter (Model Minolta CR-400, Japan) which has been calibrated using a Standard white plate (No: 19633162) to determine the value of L^* (Lightness: L^*=100 for white and 0 for black), a^*(redness/greenness axis: positive a^* is red and negative a^* is green), b^* (yellowness/ blueness axis: positive b^* is yellow).

Dry Matter Determination

For determination of the dry matter content, approximately 5 g of homogenised sample was dried in a vacuum oven at 70°C less than 100 mmHg pressures until reaching constant weight (AOAC, 2000).

Determination of pH

The pH of the plants extracts was diluted with 1:10 distilled water and measured using a pH meter (Eutech Cyberscan, Singapore). pH was measured at room temperature and stirred before the reading was taken. Calibration of the pH meter was carried out using pH 4 and 7 buffers (AOAC, 2000).

Determination of Ascorbic acid

Ascorbic acid (AA) content was determined by Lee et al. (1999)'s method. In order to do this, a certain amount of sample was weighed and extracted with 2.5% phosphoric acid solution and centrifuged at +4°C and 6500 rpm for 10 minutes. The clear part was passed from 0.22 µm teflon filter and given to HPLC device. The mobile phase was taken as 2% KH_2PO_4, flow rate was taken as 0.5 mL/min, wave length was taken as 245 nm and the injection volume was taken as 10 µL. Calibration curve prepared with different concentrations of ascorbic acid solutions which were prepared with pure ascorbic acid (99% pure, Carlo Erbaa, Code No: 390604) were used in calculating the results. Retention time of pure ascorbic acid at 245 nm was found to be 7.01 minutes on average.

HPLC (Shimadzu Corporation, Kyoto, Japan) system which consisted of LC-20AT pump unit, SPD-M20A PDA detector, SIL-20A automatic sampler, CBM-20A system control unit and CTO-10ASvp colon oven were used for ascorbic acid analysis. ACEC18 (250 mm, 4.6 mm, 5µm) was used as the colon in the analysis. Ultra-pure water obtained with Millipore, Direct-QUV3 system was used in mobile phase and samples.

Determination of Total Phenolics (TPO)

Total phenolic contents of the samples were determined by the Folin–Ciocalteu procedures according to the method of Mladenović et al. (2011) with minor changes. In brief, Folin-Ciocalteu reagent was diluted 10-fold with deionised water. The 80% methanolic plant extracts (0.5 mL) were mixed with 2.5 mL of the diluted Folin–Ciocalteu reagent and incubated for 10 min at room temperature. Then, 2 mL of 7.5% sodium carbonate (w/v) solution was added. The mixture was allowed to stand in the dark for 120 min before measuring the absorbance at 765 nm using an UV-Visible spectrophotometer (Thermospectronic-Helios Gamma, UK) against a blank, containing deionised water instead of sample extract. TPO values were determined from a calibration curve prepared with a series of gallic acid standards (0, 5, 10, 20, 30, 40 and 50 mg/L). Results are expressed as mg of gallic acid equivalents/kg dry weight (mg GAE/kg DW).

Determination of Antioxidant Activity

The bulb and leaf parts of the plants were subjected to an antioxidant activity assay. Two methods were used to determine the antioxidant activity: Ferric Reducing/Antioxidant Power (FRAP) and the 2,2-diphenyl-picrylhydrazyl (DPPH) radical-scavenging activity tests.

FRAP Assay

FRAP of the methanolic extracts was evaluated according to the method of Gao et al. (2000) with some modification. The FRAP reagent was prepared from 1 mL of a TPTZ solution (10 mM) in hydrochloric acid (40 mM) and 1 mL of a $FeCl_3$ solution (20 mM) mixed with 10 mL of an acetate buffer (300mM, pH 3.6). For the determination of the antioxidant activity, the FRAP reagent (950µL) was mixed with 50 µL of the sample extracts, Trolox (6-hydroxy-2,5,7,8-tetramethylchromane-2-carboxylic acid) standard or control (80% methanol). The reaction mixture was allowed to stand for 5 min at room temperature (ca. 20°C) before the absorbance at 593 nm was measured. A calibration curve was performed over a range of 0-500 µmol/L concentration of Trolox. The results were expressed as µmol Trolox Equivalents/g dry weight sample.

DPPH Radical Scavenging Activity

The free radical-scavenging activity was determined using 2,2-diphenyl-1-picrylhydrazyl radical (DPPH) according to Tural and Koca, (2008), with some minor revisions. Methanolic extracts (50µL) were added to1 mL of DPPH solution ($6x10^{-5}$ M in methanol) and the absorbance of the DPPH solution was determined at 517 nm after 120 min of incubation at room temperature. Methanolic solutions of Trolox (80%) in a range of 0-500 µmol/L were used for calibration to compare the antioxidant activity of the extracts. The results were expressed as µmol Trolox equivalents/g dry weight sample (µmol Trolox/g DW).

Determination of Organosulphur (Alliin and Allicin)

The plants were directly analysed with IR according to Lu et al. (2011a) and the absorption bands of organosulphur compounds were determined. Fourier Transform Infrared (FT-IR) spectra were obtained by using a Perkin ELMER FT-IR spectrometer (PIKE MIRacle TM ATR). Measurements were carried out at 20°C. Infrared spectra were recorded from 4000 to 650 cm^{-1}.

TGA/DSC (Simultaneous Differential Thermal Analysis System (SDT))

In TGA/DSC analysis, the changes that occurred in the sample with temperature increase were monitored. TA Instruments Q600 model simultaneous analysis device was used for this purpose. Capless, reference and sample pans made of platinum were used for measurement. The mass of samples was taken as 17 mg. The analyses were conducted at N_2 atmosphere. Gas flow speed was adjusted as 20 mL/min. Measurement was conducted between a temperature range of 25 and 1000°C (Al-Wafi, 2005).

Statistical Analysis

Analyses were performed in triplicates. SPSS 21 package program (two ways ANOVA) was used to compare the analysis results of samples which were harvested from different locations of 3 cities and grouped in two (bulb and leaf). Duncan's multiple range test was used to compare the leaf and bulb parts of the averages of locations. Two ways Pearson method was used to analyse the correlation between natural antioxidants and antioxidant activity.

Results and Discussion

Physicochemical Properties of the Plants

Physicochemical properties of the plants harvested from 3 different cities in terms of both bulb and leaf parts are given in Table 1.

As can be seen from the Table, lightness value was between 42.34 and 63.36 in bulbs, between 31.90 and 44.58 in leaves; greenness value was between -0.11 and -0.744 in bulbs, between -5.68 and -11.86 in leaves and yellowness value was between 2.78 and 9.05 in bulbs and between 10.75 and 19.45 in leaves. No statistically significant difference was found between the location and greenness values ($P>0.05$). Dry matter (D.M., %) changed between 20.29% and 31.71% in bulbs and between 12.88% and 33.20% in leaves. Changes in dry matter were big in terms of location and the differences between cities were found to be statistically significant ($P<0.05$). pH value was found to be between 6.51 and 6.75 in bulbs and between 5.14 and 5.76 in leaves. While the pH values of bulbs showed less variation, pH values of leaves varied more and this variation was found to be statistically significant ($P<0.05$).

Table 1 Some physicochemical properties of different parts of the plants were grown in different locations (mean ± standard deviation, variations) (n=7)

Parameters	Parts	A	B	C
*L**	bulbs	61.87±1.15^{a} (59.76-63.36)	52.80±6.85^{b} (42.34-61.21)	56.40±2.97^{b} (51.35-58.95)
	leaves	38.08±2.57 (34.75-40.92)	37.03±4.13 (32.84-44.58)	36.90±4.33 (31.90-43.06)
*a**	bulbs	-0.39±0.26 (-0.13-(-)0.74)	-0.29±0.17 (-0.11-(-) 0.53)	-0.44±0.20 (-0.19-(-)0.86)
	leaves	-9.43±1.27 (-8.11-(-)11.86)	-9.49±0.66 (-8.65-(-)10.33)	-8.48±1.79 (-5.68-(-)10.38)
*b**	bulbs	4.79±0.94^{b} (2.78-5.66)	5.17±0.46^{b} (4.62-5.60)	7.31±1.23^{a} (5.71-9.05)
	leaves	12.57±1.85^{b} (10.75-16.13)	15.83±2.05^{a} (13.48-19.45)	13.78±1.96^{ab} (11.69-16.73)
D.M., %	bulbs	28.00±1.56^{b} (26.05-30.34)	20.75±0.42^{c} (20.29-21.58)	29.65±1.32^{a} (28.39-31.71)
	leaves	16.69±3.42^{b} (12.88-23.90)	17.67±1.05^{b} (16.62-19.88)	29.10±2.26^{a} (26.94-33.20)
pH	bulbs	6.66±0.06 (6.55-6.75)	6.63±0.06 (6.55-6.73)	6.66±0.08 (6.51-6.74)
	leaves	5.46±0.16^{b} (5.25-5.75)	5.37±0.10^{b} (5.14-5.45)	5.65±0.076^{a} (5.54-5.76)

*There is no statically difference between the averages shown in the same line and letters ($P>0.05$), **A: Samsun location, B: Nevşehir location, C: Tokat location

Table 2 Antioxidant properties (in dry weight) of different parts of the plants grown different locations (mean ± standard deviation, variations) (n=7)

Parameters	P	A		B		C	
		M+St	V	M+St	V	M+St	V
TPO	B	481.04±139.39	302.00-645.81	596.62±90.05	515.02-780.68	649.46±265.28	254.51-927.81
mg/kg	L	17400.34±1489.04[a]	15621.43-19645.24	7570.40±694.62[b]	6907.14-8645.24	2110.00±205.00[c]	1929.05-2557.62
AA	B	80.81±26.89	51.50-127.62	95.86±80.06	29.14-225.13	125.05±121.63	29.59-314.01
mg/kg	L	762.37±310.36[a]	514.55-1383.16	271.60±62.87[c]	200.64-365.59	495.16±90.35[b]	357.34-605.53
FRAP	B	3.92±0.84[a]	3.11-5.20	2.90±0.59[b]	1.99-3.59	1.74±0.53[c]	(0.80-2.51
µmol TE/g	L	42.95±3.28[a]	39.30-47.83	19.37±3.09[b]	15.22-22.98	16.08±1.40[c]	(14.31-18.53
DPPH	B	6.23±1.12[a]	5.24-8.28	2.06±0.83[b]	0.99-3.11	6.07±1.97[a]	(3.21-9.02
µmol TE/g	L	144.81±45.26[a]	111.05-241.06	40.64±5.19[c]	36.61-51.54	75.42±10.90[b]	(54.07-86.39

P: Parts, B: bulbs, L: leaves, M+St: mean ± standard deviation, V: variations, * There is no statically difference between the averages shown in the same line and letters (P>0.05), **A: Samsun location, B: Nevşehir location, C: Tokat location

Akinwande and Olatunde, (2015) recorded pH values in three different onions and garlics as 5.89, 5.90, 5.85 and 6.61, respectively. It was found that the pH values found in the bulb parts of the samples of this study were higher than those found in Akinwande and Olatunde, (2015)'s study, while the results were in parallel with garlic results.

Antioxidant Properties

Antioxidant analysis results of the bulb and leaf parts of the plants are given in Table 2.

Among all the cities, the lowest and highest total phenol content of the samples were between 254.51 and 927.81 and between 1929.00 and 19645.24 mg/kg, respectively, while lowest and highest FRAP values were between 0.80 and 5.20 and between 14.31 and 47.83 mM TE/g, lowest and highest ascorbic acid content was between 29.14 and 314.01 mg/kg and between 200.64 and 1383.16 mg/kg and lowest and highest DPPH free radical scavenger effect was between 0.99 and 9.02 and between 36.61 and 241.06 µmol TE/g.

Lu et al. (2011b) found the total phenol content analysis results of 5 different garlic samples as 15.61, 19.69, 17.35, 16.20 and 15.62 mg gallic acid/g, respectively. Mladenovic et al. (2011) found the total phenol content of the bulb and leaf parts of *Allium porrum* L. species as 69.46 and 45.39 mg GAE/g. Ashwini et al. (2013) found the total phenol contents of two different onions (*A. cepa*) as 15.7-34.7 mg/g GAE respectively. Mitic et al. (2014) found the total phenolic content of the methanol extract of bulb part of *Allium scorodoprasum* plant as 36.692 µg GA/mg.

Lu et al. (2011a) found the FRAP values of white, yellow, red, sweet and pearl onion as 4.38, 5.32, 5.76, 2.48 and 6.40 µmol Trolox/g FW, respectively. Ashwini et al., (2013) found the FRAP values of two different onion types (*A. cepa*) as 0.9 and 3.3 µM/100 mg, respectively.

Colina-Coca et al. (2014) found the Vitamin C levels of crushed and chopped onions between 3.92 mg/100g and 5.03 mg/100g. Venkadachalam et al. (2014) found the ascorbic acid level of red onion as 28.12 mg/100g. Akinwande and Olatunde, (2015) found the Vitamin C levels of three types of onion (*Allium cepa* L.) and garlic (*Allium sativum* L.) as 20.67 mg/100g, 18.15 mg/100g and 8 mg/100, respectively. The values reported by Colina-Coca et al. (2014), Akinwande and Olatunde, (2015) and Venkadachalam et al. (2014) are in parallel with our values.

Lu et al. (2011a) found the DPPH free radical scavenger effect of white, yellow, red, sweet and pearl onion as 3.04, 4.56, 5.20, 1.42 and 5.71 µmol Trolox/g FW, respectively. Lu et al., (2011b) found the DPPH free radical scavenger effect of a total of 5 different garlics, 4 types of garlic grown in 4 different regions (California, Washington, New York and Oregon) and elephant garlic grown in California as 7.60, 9.78, 9.47, 8.95 and 6.95 µmol Trolox/g FW, respectively. Ashwini et al. (2013) reported the DPPH free radical scavenger effect of two different types of onions (*A. cepa*) as 6.5% and 11.8%.

Likewise, the total antioxidant status of *Sativa multicaulis* cultivated in Turkey has been investigated using Rel Assay Kits. As result, *Sativa multicaulis* displayed an important antioxidant activity, estimated at 6.434 mmol Trolox equiv./L (Pehlivan and Sevindik, 2018). When compared the antioxidant status of *Allium scorodoprasum* and *Sativa multicaulis*, it can be assumed that the FRAP values of *Allium scorodoprasum* detected in the present study were higher. Similarly, Sevindik et al. (2017) have evaluated the antioxidant capacity and the total antioxidant status of the ethanolic extracts of *Mentha longifolia* L. Hudson subsp. *Longifolia* grown in Turkey with the application of DPPH assay and Rel Assay Kit, respectively. Their study revealed that the DPPH values of *Mentha longifolia* L. Hudson subsp. *Longifolia* varied from 48.46% to 92.94% for the sample concentrations ranged between 25 to 200 µg/mL, while the values of the total antioxidant status were found to be ranged between 1.809 and 3.628 mmol Trolox equiv./L for different locations. These findings indicated that these plants have high antioxidant activity, however, the species of *Allium* studied in the present study displayed higher antioxidant activity.

In the correlation analysis conducted based on Pearson method, positive correlation was found between FRAP values and total phenolic matter (r=0.960**), ascorbic acid (r=0.643**) and DPPH (r=0.826**). Positive correlation was found between DPPH and total phenolic matter (r=0.713**), FRAP (r=0.826**) and ascorbic acid (r=0.870**). The correlation between total phenol and ascorbic acid (P<0.05) is statistically significant while all the other correlations are statistically very significant (P<0.01). No statistically significant correlation was found between any of the characteristics according to the Pearson method conducted in the bulb part of the plants.

IR and TGA Analysis Results

For the qualitative analysis of the organosulphur compounds of bulb and leaf parts of the plants harvested from different cities, measurements of all samples were made in FT-IR spectrophotometry and their absorption bands were determined. The spectra of the bulb and leaf parts of the plant are given in Figure 1 and Figure 2.

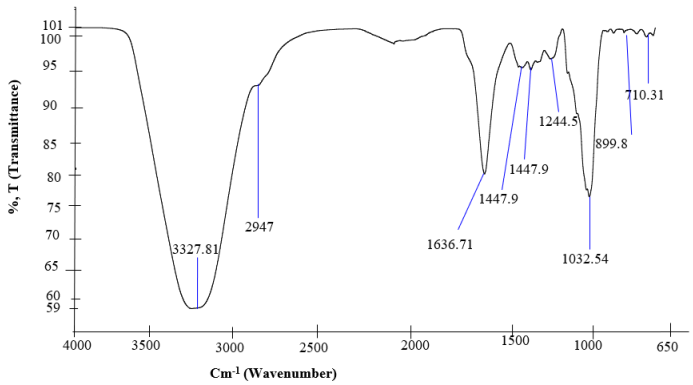

Figure 1 Spectra of fourier transform infrared (FTIR) of the bulb part of the plants (A village).

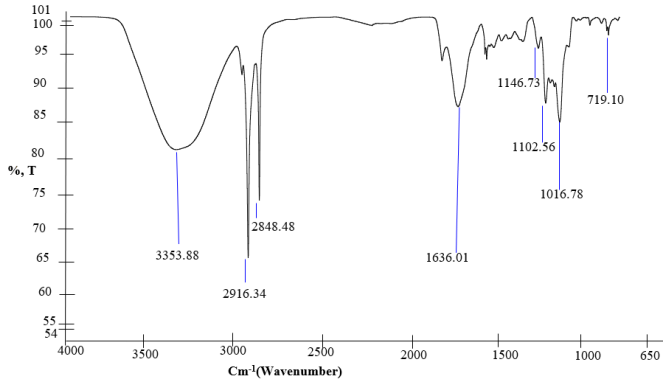

Figure 2 Spectra of fourier transform infrared (FTIR) of the leaf part of the plants (A village)

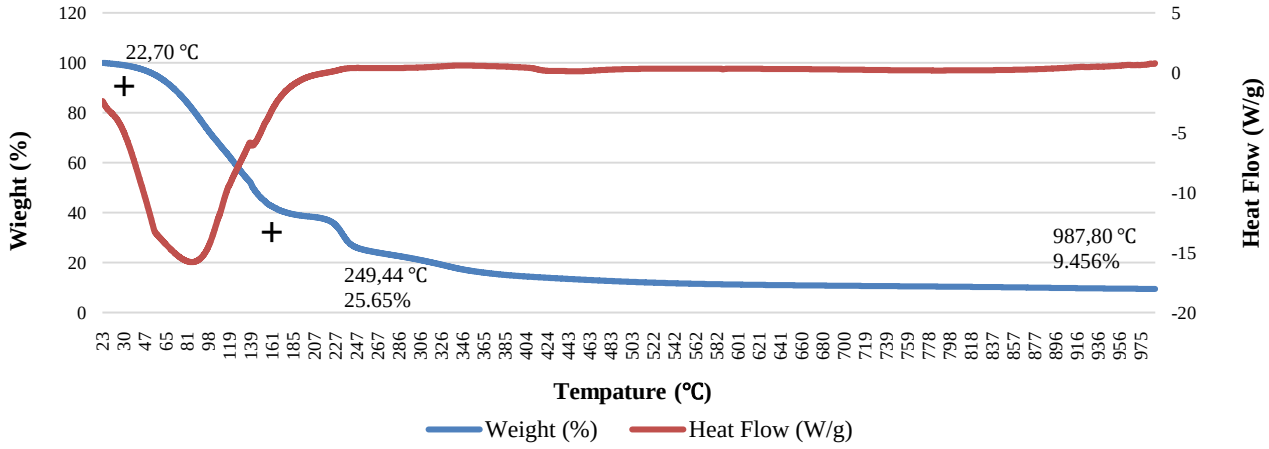

Figure 3 Thermogram of bulbs of the plants (A village)

The difference between leaf parts of the samples was found to be statistically significant in terms of cities (P<0.05).

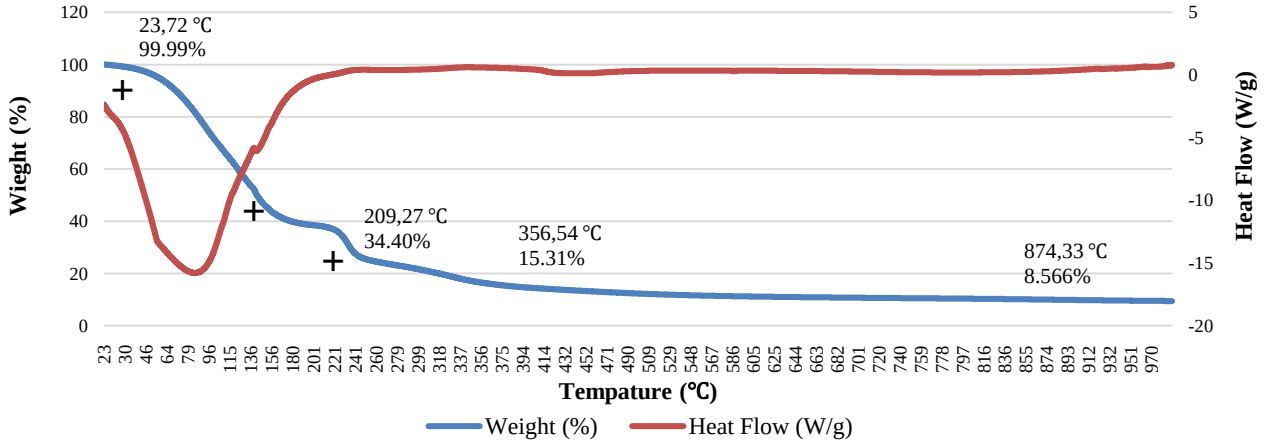

Figure 4 Thermogram of leaves of the plants (A village)

Different spectra were obtained from the leaf and bulb parts. The peaks obtained and their bonds can be interpreted as follows: first peak 3327.81 cm^{-1} ($CH=CH_2$) at the head part spectrum of garlic belongs to allyl group bond, second peak 2947 cm^{-1} belongs to aliphatic CH group bond, third peak 1636.71 cm^{-1} belongs to C=C bond, fourth peak belongs to 1032.54 cm^{-1} S=O bond, fifth peak belongs to 899.87 cm^{-1} C-S bond and the sixth peak belongs to 710.31 cm^{-1} S-S bond.

The second peak at the spectrum of the leaf part of the plant 2916.34-2848.48 cm^{-1} (double peak) belongs to NH_2 group. The other peaks at the leaf part were interpreted the same with the bulb part. When the areas where the functional groups in the formula of allicin and allyl structural form gave their peaks were solved, the presence of both compounds was found as a result of spectral measurement. In the leaf part, allyl group is more due to NH_2 bond while allicin compound is more in the bulb part.

Pirak et al. (2012) measured the characteristic frequency of allicin at IR spectrum between 1364 and 1087 cm^{-1}. In their study, Songsungkan and Chanthai, (2014) reported the peaks and their functional groups as (S=O) 1026-1030 cm^{-1}, (S-H) 2382 cm^{-1}, (C=C) 1648 $cm^{-1}$and (C-C) 1465 cm^{-1}. In their study, Lu et al., (2011b) measured the characteristic peaks of allicin as 3082, 1634, 1423, 1218, 986, 920, 721 and 477 cm^{-1}.

TGA/DSC Analysis Results

Figure 3 gives the thermogram of the bulb part of the plant grown in Samsun while Figure 4 gives the thermogram of the leaf part of the same sample.

Thermal behaviours of the sample according to Figure 3 are as follows: in the first step, weight loss started at 25°C and was completed at approximately 138°C. At this stage, there was a big decrease in the sample weight as much as 47.4%. This decrease is probably caused by the moisture in the body of the sample. Endothermic 27% weight loss that occurs between 138-249°C at the second step is thought to correspond to alliin which is known to have a boiling point of 167°C and other volatile sulphur compounds to get away from the structure. In the last step between 249 and 988°C, the other heavy aromatic compounds in the sample (16.2% experimental weight loss) got away from the structure and 9.5% dry product was left. The thermogram of the leaf part of Samsun sample and the graphics of the both bulb and leaf parts of the samples from all countries have the same profile.

Conclusions

Recently, the significance of medical plants has been increasing due to the side effects of chemical products and the fact that they are not economical. *A. scorodoprasum* subsp. *rotundum*, which is one of the allium plants, is a plant consumed due to its effects of prolonging the shelf life of the product, giving flavour and its health effects as well as being used as food in public. The purpose of this study was to determine the natural antioxidants of *A. scorodoprasum* subsp. *Rotundum* plants which is naturally grown in three different cities. In the study both the leaf and the bulb parts of the plant were analysed separately. The results of the analysis showed that the leaf parts of samples showed significant difference ($P<0.05$) in terms of the location they were grown in. The bulb parts of the samples of all cities were found to include lower antioxidant compound and antioxidant activity when compared with the leaf parts. The physicochemical characteristics, antioxidant compound and antioxidant activity values of the bulb and leaf parts of the plants were found to differ in terms of the climatic conditions and soil characteristics of the region the plants were grown.

Acknowledgment

This study has been performed for my master's degree thesis work. The authors thank Ondokuzmayıs University Scientific Research Projects Unit (Project No. PYO.MUH.1904.15.022) for financial support.

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