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Total Phenolics, Mineral Elements, Antioxidant and Antibacterial Activities of Some Edible Wild Plants in Turkey

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Total phenolic content, macro and micro elements (N, P, K, Ca, Mg, Na, Fe, Mn, Zn and Cu), antioxidant and antibacterial activities of leaves of some edible plants (*Sinapis arvensis* L., *Polygonum aviculare* L. and *Tragopogon aureus* Boiss.) grown wild in Eastern Anatolia region of Turkey were studied. The total phenolic content was found between 12.56 µgGAE/mg (*T. aureus*) and 22.25 µgGAE/mg (*S. arvensis*). All three species showed high antioxidant activity and among them *T. aureus* possessed the highest one (88.64 %). There was a low correlation (R = 0.447) between total phenolic content and antioxidant activity in the plant samples. N, P and K values of plants were between 1.98 % (*T. aureus*) and 3.44 % (*S. arvensis*); 164 mg/100 g (*T. aureus*) to 255 mg/100 g (*S. arvensis*) and 2005 mg/100 g (*P. aviculare*) to 2710 mg/100 g (*T. aureus*), respectively. The methanol extracts of the leaves of species showed antibacterial activities against a number of microorganisms searched. However, none of the water extracts of plants showed antibacterial activity on the microorganisms studied.

Key Words: Antioxidants, Antibacterial activity, Phenolics, Edible wild plants, Turkey.

INTRODUCTION

Turkey is one of the most important countries in the temperate world, in terms of floristic diversity. The Turkish flora is estimated to contain more than 11,000 specific and infraspecific taxa of higher plants of which about 3000 are endemic. This exceeds the total number of endemic species found in Europe and underscores the ecological importance of the country[1].

In Anatolia, plants have been used as a source of food, herbal medicine, animal fodder, tinder and some utensils from time immemorial[2]. The Eastern Anatolia region is one of the richest wild edible plant diversity centers in Turkey. For centuries, in this rural area local people used wild

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edible plants, including *Sinapis arvensis* L., *Polygonum aviculare* L. and *Tragopogon aureus* Boiss. both for food and herbal medicine[2].

Finding healing powers in plants is an ancient idea. People on all continents have long applied poultices and imbibed infusions of hundreds, if not thousands, of indigenous plants, dating back to prehistory[2]. Recent reports indicate that there is an inverse relationship between the dietary intake of antioxidant-rich foods and the incidence of human diseases[3]. Hence search for new synthetic and natural antioxidants is essentially important. Although initial research on antioxidants was mostly on isolated pure compounds, recent focus is more on natural formulations[4]. Plant products are also known to possess potential for food preservation and the antioxidant capacity of plant extracts strongly related to their phenolic compounds[5].

Most of the plant families represent a reservoir of effective chemotherapeutics and can provide valuable sources of natural antimicrobials[6]. Thus, for many thousands of years plant extracts have been used for a wide variety of purposes[7]. In particular, the antimicrobial activity of plant extracts has formed the basis of many applications, including raw and processed food preservation, pharmaceuticals, alternative medicine and natural therapies[8]. Recently, the acceptance of traditional medicine as an alternative form for health care and the development of microbial resistance to the available antibiotics have led authors to investigate the antimicrobial activity of medicinal plants[9,10].

Tragopogon aureus, perennial, that occurs across Eurasia from the Atlantic to the Pacific Ocean, with a center of distribution in the Mediterranean region, the Middle East and Eastern Europe. Mature plants are 10-30 cm tall, stems unbranched and leaves lanceolate. It is found on rocky slopes, steppe and field margins between 1700-2300 a.s.l. in Turkey[11].

Sinapis arvensis, annual, that occurs West, Central and South Europe, North Africa and South West Asia. Mature plants are 20-60 cm tall; stems are branched have upper leaves that are toothed and lower leaves its deep lobes, both hairy underneath. It is found on roadside and waste places between 0-1800 a.s.l. in Turkey[12].

Polygonum aviculare, annual, that occurs mainly in Europe. Mature plants are prostrate and stems are branched. Leaves and ochreae are overlapping. It is found mainly on waste places between 0-700 a.s.l. in Turkey[13].

Sinapis arvensis, *Polygonum aviculare* and *Tragopogon aureus* are widespread wild edible household herbs in Eastern part of Turkey. The local peoples who live in the Eastern part of Turkey eat *Sinapis arvensis* and *Tragopogon aureus* as uncooked. Moreover, local people also use *Polygonum aviculare* and *Tragopogon aureus* plants for wound healing, urinary disorders, diabetic and anticancerogen as well[2]. In Eastern part of Turkey, young leaves of *Sinapis arvensis* are used for meat stuffed with leaves.

Though antioxidant activity of *Polygonum aviculare* has been previously reported[14], there is no report on the *Sinapis arvensis* and *Tragopogon aureus*. In addition antibacterial activity and mineral element contents of those species has not been reported.

The aims and objectives of the study were to estimate the mineral elements and total phenolic content of selected wild edible plants, *Sinapis arvensis*, *Polygonum aviculare* and *Tragopogon aureus* to evaluate the antioxidant and antibacterial activity and compare the mineral elements, total phenolic content, antioxidant and antibacterial activities of these plants.

EXPERIMENTAL

Mature edible plants (*S. arvensis* L., *P. aviculare* L. and *T. aureus* Boiss.) were harvested manually ten locations with similar soil types from rural area of Erzurum city in Eastern Anatolia region of Turkey. At least 30 separate plants were pooled to form a single plant sample. They were packed in a portable refrigerator during transportation to the laboratory (2-3 h). The samples from different locations were combined prior to analysis. Leaves separated from plants and dried at 50ºC in an oven then dried leaves were ground to a fine powder with a mortar and pestle and kept at room temperature prior to extraction for antioxidant activity and total phenolics analysis. The total phenolics was determined by the Folin-Ciocalteau method[15]. The antioxidant activity of methanol extracts was determined according to the β-carotene bleaching method[16]. Mineral elements was determined by James[17]. Antibacterial activity was determined by Ozturk and Ercisli[18].

The experiment was completely randomized design with four replications. Data were subjected to analysis of variance (Anova) and means were separated by Duncan multiple range test at $p < 0.05$ significant level.

RESULTS AND DISCUSSION

Antioxidant activity of *S. arvensis*, *P. aviculare* and *T. aureus* leaves are given in Fig. 1. It can be seen that there is no statistical differences among butylated hydroxy anisole (BHA), butylated hydroxy toluene (BHT) and plant extracts in terms of antioxidant activity. The antioxidant activity reached nearly 100 % for the standard BHA (200 mg/L) as 98.16 % and BHT (200 mg/L) as (96.66 %), *Tragopogon aureus* (88.64 %), *Polygonum aviculare* (87.31 %) and *Sinapis arvensis* (86.98 %), respectively. In other words antioxidant activity decreased in the following order: BHA > BHT > *T. aureus* > *P. aviculare* > *S. arvensis*. This suggests that these extracts may contain high concentrations of active compounds. In a previous study, it is reported that extracts of Polygonum aviculare had antioxidant activity[14] which support present findings.

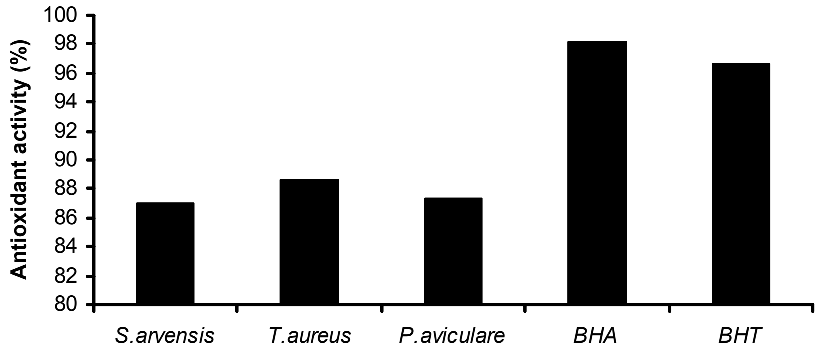

Fig. 1. Antioxidant activity in *S. arvensis, P. aviculare* and *T. aureus*, BHA and BHT

The amounts of total phenolics in the studied wild edible plants are shown in Fig. 2. A high content was observed for *S. arvensis* (22.25 µg GAE/mg) and followed by *P. aviculare* (15.38 µg GAE/mg) and *T. aureus* (12.56 µg GAE/mg), respectively. Here, it can be seen that there is statistical difference among plant extracts in terms of total phenolic content ($p < 0.05$). In addition, there was a low correlation ($R = 0.447$) between total phenolic content and antioxidant activity in the plant samples. Several

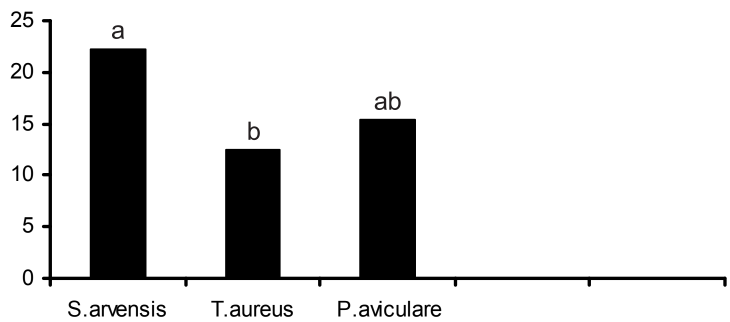

Fig. 2. Total phenolic content (µg GAE/mg) of *S. arvensis*, *P. aviculare* and *T. aureus*

studies have reported on the relationship between phenolic content and antioxidant activity. Some authors found a correlation between the phenolic content and the antioxidant activity, while others found no such relationship. Velioglu *et al.*[15] reported a strong relationship between total phenolic content and antioxidant activity in certain plant products. Kahkonen *et al.*[19] reported that no significant correlations could be found between the total phenolic content and the antioxidant activity of 92 plant extracts of the studied subgroups. Some authors proceeded to comment that different phenolic compounds show different colourimetric responses when using the Folin-Ciocalteu reagent. Similarly, the molecular antioxidant response to free radicals varies markedly, depending on the chemical structure and the oxidation conditions. Thus, the antioxidant activity of an extract cannot be predicted on the basis of its phenolic content. In this study, the findings do not show a conclusive relationship between total phenolic content and antioxidant activity (Fig. 3). For example, *S. arvensis*, had the highest level of phenolic content but had the lowest antioxidant activity. The present results do not show whether there is correlation between antioxidant activity and total phenolic content.

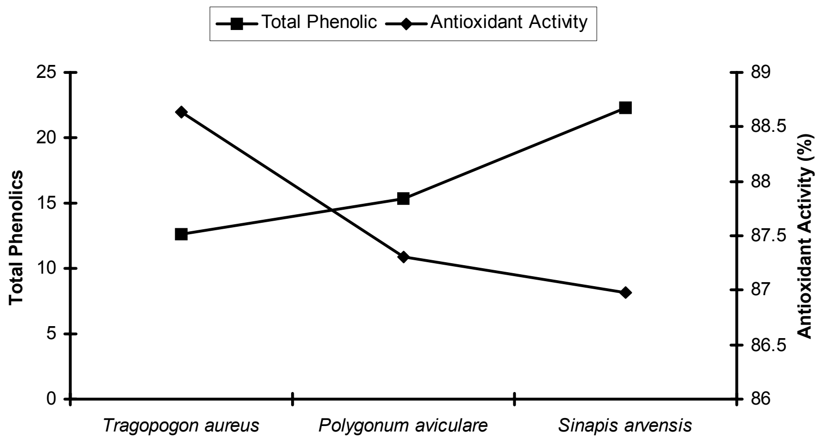

Fig. 3. Total phenolic content and antioxidant activity of *S. arvensis*, *P. aviculare* and *T. aureus*

The mineral contents of *S. arvensis*, *P. aviculare* and *T. aureus* are shown in Table-1. N, P, K, Ca, Mg, Na, Fe, Cu, Zn and Mn values varied from 1.98 % (*T. aureus*) to 3.44 % (*S. arvensis*); 164 mg/100 g (*T. aureus*) to 255 mg/100 g (*S. arvensis*); 2005 mg/100 g (*P. aviculare*) to 2710 mg/100 g (*T. aureus*); 344 mg/100 g (*T. aureus*) to 666 mg/100 g (*S. arvensis*); 122 mg/100 g (*T. aureus*) to 137 mg/100 g (*P. aviculare*); 3 mg/100 g (*T. aureus*) to 5 mg/100 g (*P. aviculare*); 132 mg/100 g (*T. aureus*) to 308 mg/100 g (*P. aviculare*); 0.08 mg/100 g (*S. arvensis*) to 0.15 mg/100 g (*P. aviculare*); 4 mg/100 g (*S. arvensis*) to 7 mg/100 g (*T. aureus*); 19 mg/100 g (*T. aureus*) to 47 mg/100 g (*P. aviculare*), respectively (Table-1). According to the literature searched, there is no results related to mineral element composition of *S. arvensis*, *P. aviculare* and *T. aureus*. The mineral composition of plants depended, not only on the species or varieties, but also on the growing conditions such as soil and geographical condition.

TABLE-1
MINERALS CONTENT IN *S. arvensis, P. aviculare* AND *T. aureus*

Plant	N (%)	Mineral elements (mg/100 g DW)								
		P	K	Ca	Mg	Fe	Mn	Zn	Na	Cu
T.aureus	1.98	164	2710	344	122	132	19	7	3	0.13
S.arvensis	3.44	255	2425	666	136	242	28	4	5	0.08
P.aviculare	2.31	212	2005	444	137	308	47	5	5	0.15

The antibacterial activity of *S. arvensis*, *P. aviculare* and *T. aureus* against a number of bacteria is shown in Table-2. The *S. arvensis* extract showed antibacterial activity against *Agrobaceterium tumefaciens*, *Bacillus cereus, Pseudomonas aeruginosa, Pseudomonas corrugate, Pseudomonas syringae* pv. *tomato*, *Yersinia frederiksenii*, *Yersinia pseudotuberculosis* and *Xanthomonas compestris compestris* (7-13 mm inhibition zone). The *P. aviculare* extract showed antibacterial activity against *Bacillus cereus*, *Bacillus subtilis, Pseudomonas syringae* pv. *tomato*, *Yersinia frederiksenii* and *Yersinia pseudotuberculosis* (7-9 mm inhibition zone). The *T. aureus* extract showed antibacterial activity against *Bacillus cereus*, *Bacillus subtilis*, *Pseudomonas syringae* pv. *tomato* and *Xanthomonas compestris compestris* (7-9 mm inhibition zone). However, none of the aqueous extract of species showed bacterial activity on the studied microorganisms (Table-2). All the three plant extracts did not display any antibacterial activity against *Coryneum diphteriae, Pseudomonas syringae* pv. *syringae, Salmonella typhimurium, Serratia liquefaciens, Vibrio chlororae* and *Yersinia enterocolita*, (Table-2). MIC values showed by the methanol extract of *S. arvensis, T. aureus, P. aviculare* and standard drug (maxipime) were in the range of 125-250, 3.90-125, 62.50-250 and 7.81-500 µg/mL, respectively (Table-2) being *Bacillus subtilis* was determined the most sensitive microorganism against to *T. aureus* plant extract with the lowest MIC value (3.90 µg/mL) than standard drug. The other sensitive microorganisms were *Pseudomonas syringae* pv. *syringae, Pseudomonas syringae* pv. *tomato* and *Xanthomonas compestris compestris* with lower MIC values than standard antibiotic (Maxipime) (Table-2). As mentioned before, *S. arvensis* and *P. aviculare* used for centuries as a medicine in pharmaceutical industry in Eastern part of Turkey because of its therapeutic properties. The results obtained in the course of the present study are in agreement to a certain degree with the traditional uses of *S. arvensis* and *P. aviculare* in particular Eastern Anatolia region of Turkey.

As a conclusion, the methanolic extracts of three plant species found in Eastern part of Turkey were found to possess phenolics as well as antioxidant activity. The results gained in these assays provide simple data that

TABLE-2
ANTIBACTERIAL ACTIVITY OF *S. arvensis*, *P. aviculare* AND *T. aureus* EXTRACTS AGAINST A NUMBER OF BACTERIA

Bacteria speices	Inhibition zone in diameter (mm) of extract (10 µg/disc)			Water extract	Negative control MeOH	Positive control (mm)			MIC values (µg/mL) extract			Standard drug Maxipime
	S. arvensis	*P. aviculare*	*T. aureus*			Net	Sfe	Ofx	*S. arvensis*	*P. aviculare*	*T. aureus*	
Pseudomonas syringae pv. *Syringae*	-	-	-	-	-	16	-	16	250	125	125	250
Pseudomonas syringae pv. *Tomato*	7	7	8	-	-	20	-	-	250	125	125	250
Bacillus subtilis	-	7	9	-	-	30	40	26	125	3.90	62.50	7.81
Bacillus cereus	7	7	7	-	-	19	19	21	250	62.50	125	31.25
Yersinia enterocolita	-	-	-	-	-	-	19	-	250	62.50	125	31.25
Vibrio chlororae	-	-	-	-	-	16	39	21	250	62.50	125	62.50
Coryneum diphteriae	-	-	-	-	-	-	-	-	250	62.50	125	-
Yersinia frederiksenii	7	-	9	-	-	12	19	18	250	62.50	125	31.25
Yersinia pseudotuberculosis	7	-	9	-	-	17	12	16	250	125	62.50	31.25
Salmonella typhimurium	-	-	-	-	-	-	9	-	250	125	125	-
Serratia liquefaciens	-	-	-	-	-	14	-	10	250	125	125	62.50
Pseudomonas corrugata	7	-	-	-	-	13	10	23	250	125	62.50	-
Xanthomonas compestris compestris	8	9	-	-	-	9	15	15	250	125	125	500
Agrobaceterium tumefaciens	8	-	-	-	-	16	25	23	125	62.50	250	-
Pseudomonas aeruginosa	13	-	-	-	-	14	12	17	250	125	62.50	250

make it possible to classify extracts according to their total phenolic content and antioxidant potential. There is a need to characterize phenolic compounds present within each plant extracts, so as to assign different antioxidant activities, to ascertain whether phenolic structure affects antioxidant activity and also to determine whether synergism definitely occurs between certain phenolic compounds. The therapeutic value of the plant extracts may be partly because of their antioxidant activity. Further studies on the absorption and effects of phytochemicals present in the plant extracts on antioxidant status in animal models are needed to evaluate their potential health benefits. Based on these results, it is possible to conclude that aerial parts of *S. arvensis*, *P. aviculare* and *T. aureus* have antibacterial activity against a number of bacteria.

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