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Nutritional value and chemical composition of common purslane (Portulaca oleracea L.) from different regions in Bulgaria

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Abstract. The objective of our research is to study wild *Portulaca oleracea* L., collected from different floristic regions in Bulgaria and under different soil and climatic conditions of development concerning chemical composition, mineral composition and bioactive compounds. Plant and soil samples (n = 21) were collected in the period – beginning of June till the end of September 2023 from different regions of Bulgaria (Thracian lowland, Stara planina mountain, Black Sea coast and Tundzha hilly country). The following have been determined in dry matter (DM) – moisture, dry matter, crude protein, crude fats, ash and nitrogen-free extracts (NFE), energy, carbohydrates and bread units; mineral composition (Ca, P, K, Mg, Na, Zn and Fe) and bioactive compounds in methanol extract (total phenolic compounds (TPC), total flavonoid compounds (TFC) and radical scavenging capacity). In fresh state, the samples have been tested for ascorbic acid (vitamin C), total titratable organic acids, dry matter and respective water content.

Key words: antioxidant activity, bioactive components, flavonoid composition, mineral composition, phenolic composition, purslane

Introduction

Common purslane (*Portulaca oleracea* L.) is a cosmopolitan, ruderal, invasive species and is considered a weedy plant of the Portulacaceae family (Keshavarzi, 2017). It is an annual grass with creeping or upright succulent bare stems, branched at the base, up to 50 cm long. The lower leaves are alternate and the upper ones – almost opposite, clasping, oval-shaped, oblongate obovate to spade-shaped, narrow at the base, thick, juicy, smooth. The flowers are small, yellow, single or in clusters of 2 or 3 clasping at the stem branching or at the leaf axils. There are 2 sepals, fused towards the base forming a short tubule. There are 5 petals. There are 12 stamens. The fruit is a capsule. The seeds are tiny, black, kidney-shaped (Georgiev, 1966). In Bulgaria it grows as a ruderal plant up to 1000 m a.s.l., on neglected terrains as a weed in gardens, along roads, fences, sidewalks, everywhere close to places influenced by anthropogenic activity (Anchev, 1992, Delipavlov & Cheshmedzhiev, 2003, Assyov & Petrova, 2012). Fig. 1 shows a general view of *Portulaca oleracea* L. In Bulgaria common purslane is more familiar as a weedy plant (Tonev, 2002), but in the Mediterranean countries, Asia, Africa, the Philippines, etc., it is regarded as useful and functional food and is used in culinary in fresh state for salads, in dishes and soups, marinated or blanched and as dry spice. (Sulatana & Rahman, 2013). According to data by a number of researchers, the species has high potential to be used as food for humans and animals and as a pharmacological agent in medicine (Zhou et al., 2015).

The main usable part is a stalk of purslane *Porulacea herba*. Purslane is mentioned in Egyptian

texts from the times of the Pharaohs as a plant with high nutritional value (Kesden & Will, 1987). Abd El-Aziz et al. (2014) reported that the nutriational value in purslane water extract is the following: crude protein, ash and crude fiber, T.S.S, reducing and total sugars are 3.80%, 0.82%, 0.40%, 4.70%, 1.72 % and 1.85 %, respectively, and in dry purslane samples – moisture, crude protein, crude fiber, crude ash, total suspended solids (T.S.S), reducing and total sugars are 5.14%, 18.58%, 17.99%, 16.50%, 3.06%, 3.16% and 3.72%, respecttively. While in dry samples Aberoumand (2009) reported crude protein (23.47%), crude fiber (8%), crude fats (5.26%), ash (22.66%), carbohydrates (40.67%) and calories (304 kcal.100g^{-1}).

In Bulgarian folk medicine purslane is familiar with properties, some of which are: for internal application as a laxative, diuretic, reducing cholesterol, improved lipid metabolism, antidiabetic, normalizes cardiac activity, in painful joints, hemorrhoids. For external application: fresh juice or fresh ground leaves for treatment after insect bites (Collective, 2023). In China *Portulaca oleracea* L. has been well-known and used for millennia as a medicinal plant for reducing body temperature, detoxication, hemostasis, against dysentery (The Pharmacopoeia Commission of PRC, 2015). With the advance of scientific knowledge, today it becomes possible to study the molecular mechanisms of the biological activity of medicinal plants. The study of the connections between existing empirical data from folk medicine and these mechanisms is aided by the increased capabilities of modern biological research. According to studies, purslane exhibits high pharmacological activity such as neurological protection (Abdel Moneim, 2013), anti-tumor activity (Zhao et al., 2013), anti-inflammatory (Rashed et al., 2003), antibacterial (Chan et al., 2015) and antioxidant (Chen et al., 2012). Other studies are related to defining biologically active substances and components, isolated from the plant such as phenolic acids and coumarins (Awad, 1994), flavonoids (Xu et al., 2006), terpenes (Xin et al., 2008) and alkaloids (Xiang et al., 2005; Tian et al., 2014).

In recent years there is a trend of increasing interest in alternative medicine, herbalism, food healing methods and functional foods. There are various definitions of functional foods, and according to the European Commission Group for Functional Food Science in Europe (FUFOSE) (Blades 2000), a "Functional Food" is one that has been shown to beneficially affect one or more functions in the body, beyond the main nutritional effects, in a way that is suitable for improving health and well-being and/or reducing risk. Goldberg's (1994) definition of a functional food is that any food or food ingredient that has a positive effect on the individual's physical health, performance or state of mind in addition to its nutritional value. Due to its high nutritional composition, pharmacological activity and medicinal properties, purslane arouses interest in establishing, researching and studying its nutritional composition, biologically active substances and beneficial properties.

The objective of the present study is to determine the nutritional value and chemical composition of wild purslane plants from different regions of the country with an assessment of a potential for functional food.

Fig. 1. Purslane (*Portulaca oleracea* L.)

Materials and methods

The sampling of plant and soil samples was carried out during the period from the beginning of June to the end of September, 2023. The plant samples (n = 21) were collected from four floristic regions, as follows:

- Thracian lowland – the area of Plovdiv (Area 1), Stara Zagora (Area 2), Chirpan (Area 3), Aprilovo (Area 6);
- Stara planina mountain – the area of Pavel banya – Gabarevo (Area 7);
- Black Sea coast – the area of Ahtopol (Area 5);
- Sredna gora mountain – the area of Pryaporets (Area 4).

Plant samples

The above-ground part of the plants has been collected randomly. They have been transported to the drying area in paper bags to prevent steaming from the high humidity and temperature. Initially, the samples have been placed at room temperature and then dried in a dryer at 60˚C. The dried samples were ground with a grinder. The samples to be examined fresh have been collected in paper bags and transported to the site for analysis.

Soil samples

Soil samples were taken from the same places of purslane sampling, at a depth of up to 30 cm. Sampling was made by a soil probe. After that, soil samples were dried to an air-dry state, crushed and sieved with a hole diameter of 2 mm. Table 1 presents a brief description of the sampling sites, including geographic coordinates, altitude, soil - soil type or other ground cover.

Table 1. Short characteristic of locations of sampling

Name of area	Location	Coordinates	Altitude, m	Soil type
Area 1	Thracian Lowland, Plovdiv	42°08'05.7"N 24°44'40.7"E	164	Fluvisols and Antrosols
Area 2	Thracian Lowland, Stara Zagora	42°25'15.2"N 25°37'41.9"E	196-353	Fluvisols and Luvisols
Area 3	Thracian Lowland, Chirpan	42°11'58.9"N 25°19'29.6"E	139-250	Vertisols and Antrosols
Area 4	Sredna Gora Mountain, Pryaporets	42°27'51.4"N 25°31'57.2"E	466	Antrosols
Area 5	Black Sea Coast (Southern), Ahtopol	42°05'56.8"N 27°55'41.5"E	0	Antrosols
Area 6	Thracian Lowland, Aprilovo	42°11'45"N 25°51'31"E	108	Vertisols
Area 7	Tundzha Hilly Country, Gabarevo	42°38'00.6"N 25°09'26.7"E	423	Fluvisols

Methods of analysis

Plant samples

The chemical composition has been determined from the dry samples by the generally accepted Weende method (AOAC, 2007); weight analysis (gravimetry) was used to determine moisture and dry matter, respectively - BDS ISO 6496; crude protein content was determined by the method of Kjeldahl (BDS - ISO 5983); crude fat content was determined by extraction (BDS - ISO 6492); crude fiber determination followed BDS - ISO 6865; crude ash - weight analysis (gravimetry) according to BDS - ISO 5984; nitrogen-free extracts (NFE) - weight analysis.

To determine the mineral composition, dry samples were used and the corresponding methods were: for phosphorus - colorimetry; potassium and sodium - flame photometry with Flamom - B; calcium, magnesium, iron and zinc with a Perkin Elmer ANALYST-800 AA atomic absorption spectrophotometer.

Total carbohydrates were calculated according to the following formula (Petropoulos et al., 2019):

$$\text{g.100g}^{-1}\text{ DM} = 100 \times (\text{g moisture} + \text{g fat} + \text{g ash} + \text{g proteins})$$

Calories were calculated using the following formula (Petropoulos et al., 2019):

kcal.100g^{-1} DM = 4 × (g proteins + g carbohydrates) + 9 × (g fat)

Extract preparation

An amount of each ground sample was weighed on an analytical balance and suspended in 70% ethanol at a ratio of 1:10. The extraction was carried out by ultra-sonication for 30 min at 40°C. After filtration through a 0.45 µm membrane the solid residue was rinsed with 70% ethanol in triplicate. The alcoholic fractions from each sample were collected and adjusted to a final concentration of 1 mg/ml extract. The extraction technique of ultra-sonication, and 70% ethanol as an extracting agent were picked up because quantitative extraction of polar substances from plants, such as polyphenolic compounds are, was achieved (Tzanova et al., 2020).

Determination of total phenolic content (TPC)

The experimental protocol described by Tzanova et al. (2019) was followed for quantification of TPC. In brief, 1 ml of the alcoholic plant extract was mixed with 5.0 ml of Folin-Ciocalteu's reagent (10-fold diluted). Then, 4 ml of 7.5% Na_2CO_3 was added and the tubes were left at room temperature for 60 min. The absorbance at 765 nm was measured against blank on a Thermo Scientific Evolution 300 spectrophotometer. Gallic acid (Sigma-Aldrich, St. Louis, MO) solutions in 70% ethanol ranging from 10 to 150 µg/mL were used for calibration curve (R^2 = 0.9996). TPC of each sample was expressed as milligrams gallic acid equivalents (GAE) in 1 g DM of the plant extract.

Determination of total flavonoid content (TFC)

For quantification of TFC was followed the experimental procedure described by Dinev et al. (2021). In brief, 1 ml extract, 0.3 ml 5% $NaNO_3$, and after 5 min, 0.3 ml 10% $AlCl_3$ were added in a 10 ml volumetric flask containing 4 ml deionized water in this order. After 6 min, 2 ml of 1 M NaOH was added and the total volume was adjusted up to 10 ml by deionized water. The solution was homogenized and the absorbance was measured against blank at 510 nm on a Thermo Scientific Evolution 300 spectrophotometer. Standard solutions of catechin hydrate (Sigma Aldrich, St. Louis, MO, USA) in the concentration range from 10 to 150 mg/l were used to plot the calibration curve (R^2 = 0.9989). TFC was expressed as mg catechin equivalent (CE) in 1 g DW extract.

Determination of radical scavenging capacity by DPPH method

The 2,2-diphenyl-1-picrylhydrazyl radical (DPPH) used was purchased from Sigma-Aldrich (St. Louis, MO). The method described by Tzanova et al. (2019) was applied to measure radical scavenging potential of alcoholic extracts obtained from different plant parts of the selected cowpea genotypes. In brief, to 2 ml of 100 M solution of DPPH in methanol was added 20 µl of extract prepared. Absorption at 517 nm was measured on a Thermo Scientific Evolution 300 spectrophotometer 30 min later. Since the composition of the extracts is complex, the results for their radical scavenging capacity were compared with Trolox and calculated by regression analysis from the linear dependence between concentration of Trolox and absorption at 517 nm (R^2 = 0.9995 for the linearity of the concentration range from 5 to 50 µmol/l). The results were expressed as µmol Trolox equivalent (TE) in 1 g DM of plant extract.

Vitamin C content, total organic acids, dry matter and water content were tested from fresh purslane samples. For the aqueous extract, the above-ground parts of *P. oleracea* L. were used, which were cleaned and chopped, distilled water was added in a ratio of 1:1, and then the samples were blended. The extract was filtered and used to determine the content of vitamin C according to the Tillmans method - BDS 13374 and for the titrimetric determination of total organic acids. To determine the dry matter, an unfiltered extract was used using the weight method, and the water content was calculated from there.

Soil samples

Soil samples were analyzed to determine soil structure using different sieves with hole sizes of 10 mm, 5 mm, 3.15 mm, 2 mm and 1 mm. The pH values (H_2O) were determined potentiometrically and the electrical conductivity by a Milwaukee conductometer.

Statistics

To establish the influence of the area on the mineral, chemical composition and biochemical activity of the purslane samples, statistical procedures were performed by ANOVA test. After

significant results were obtained by the ANOVA test, Tukey's HSD test was applied to all pairwise differences between means. Significant differences were tested, and p values <0.05 were considered statistically significant. The coefficients of determination R^2 were also estimated. Statistical tests are found in XLSTAT 2023.1. 2 (1406).

Results and discussion

Soil samples

Due to the varying sampling locations from the Black Sea coast, the Thracian lowland, the Tundzha hilly country and the foothills of the Stara Planina mountain, the great variety of soil types in the studied regions is explicable. For example, the soil samples collected from the common purslane collection points belong to Vertisols (Area 6), Fluvisols (Areas 1, 2, 4), Luvisols (Area 2) and Anthrosols (1, 3, 5). The latter are soils from parks, gardens and courtyards. Common purslane was found and samples were collected from areas without surface soil, from cracked pavements (Area 7) as well as from cracked asphalt (Area 1). From the determined soil properties, it has been established that soils with a neutral to alkaline reaction predominate. For example, in Area 2 soils with pH (H_2O) values from 6.9 to 7.3 prevail, in Area 3, 4, 6 the soils are characterized by an alkaline reaction, with pH (H_2O) values from 7.5 to 7.9, and only in Area 4 soil with an acidic reaction was found, with pH (H_2O) - 5.7. All soil samples were non-saline with electrical conductivity (EC) values lower than 450 μS/cm, with good structuring.

Nutritional value

Purslane is widespread in Bulgaria, the collected samples from the research areas in the country show that the nutritional value in dry samples varies. The data about minimum, maximum and average values are in % DM for the respective areas (Table 2).

The table shows that the crude protein content varies from 18.26% (Area 5) to 26.66% (Area 4), with an average value of 22.66±2.98%. Crude fat – from 3.20% (Area 6) to almost double the content – 5.84% (Area 5) and an average value – 4.62±0.88%. Crude fiber – 7.44% (Area 6) and twice as much in Area 5 – 14.38%, with the average values being 10.47±2.53%. The ash content varies from 21.02% (Area 5) to 26.62% (Area 2) and an average of 24.38±1.86%. Nitrogen-free extracts (NFE) – 34.70% (Area 7) to 40.50% (Area 5) and an average of 37.89±2.01%.

Table. 2 Nutritional value of *P. oleracea* L. from the studied areas, % DM

Number of area	Crude protein, % (DM)	Crude fat, % (DM)	Crude fibre, % (DM)	Ash, % (DM)	NFE, % (DM)
Area 1	22.64^{a}	4.26^{a}	9.78^{abc}	25.48^{a}	37.98^{a}
Area 2	20.11^{a}	4.25^{b}	9.73^{bc}	26.62^{b}	39.3^{a}
Area 3	21.93^{a}	4.74^{b}	9.51^{c}	25.5^{b}	38.33^{a}
Area 4	26.66^{a}	4.51^{a}	8.91^{bc}	24.15^{a}	35.77^{a}
Area 5	18.26^{a}	5.84^{a}	14.38^{a}	21.02^{a}	40.50^{a}
Area 6	25.94^{a}	3.20^{b}	7.44^{c}	24.78^{b}	38.63^{a}
Area 7	23.10^{a}	5.56^{b}	13.54^{ab}	23.09^{b}	34.70^{a}
Min	18.26	3.20	7.44	21.02	34.70
Max	26.66	5.84	14.38	26.62	40.50
Mean±SD	22.66±2.98	4.62±0.88	10.47±2.53	24.38±1.86	37.89±2.01

*a-b different superscripts within the same column (for each parameter) represent significant differences at the level of significance P < 0.05, DM – dry matter.

The results obtained reveal that nitrogen-free extracts have the highest percentage - 38%, followed by crude ash - 24%, from which a high mineral content can be assumed. Close to our results about crude ash were obtained by Aberoumand (2009) – 22.66% as well, while Abd El-Aziz et al. (2014) mentions lower ones – 16.50%. According to Mohamed & Hussein (1994), crude

ash is contained mostly in the above-ground part of the plant on the 30th day of development and remains the lowest in the roots. Protein content in the purslane is 23%, while Abd El-Aziz et al. (2014) reported lower values 18.58%, and in Aberoumand (2009) it was 23.66% close to the average value of the purslane samples studied by us. Mohamed & Hussein (1994) found that the highest protein content was in purslane leaves, reaching values of 44.35 mg.100 g^{-1} DM on day 59. Crude fiber is 10%, and Abd El-Aziz et al. (2014) reported much higher values - 17.99%, and in Aberoumand (2009) the values were lower - 8%. Fats have the lowest presence – 5%, which hardly differ from the values of Aberoumand (2009) – 5.26%.

Mineral composition

The obtained data on the mineral composition of *Portulaca oleracea* L. are presented in Table 3. The high crude ash percentage implies high macro and microelement content. Chemical analyses showed that the mineral composition also varies widely. The element potassium has the highest percentage - 54% of the mineral composition of the studied purslane. Its values vary within the following limits from 2079 to 4048 mg.100 g^{-1}, with the lowest values recorded in Area 4 and the highest ones in Area 6. The average value of potassium from all studied samples is 3222±653 mg.100 g^{-1}. Second ranks calcium with 19% participation in the mineral composition, varying widely from 959 to 1261 mg.100 g^{-1} with an average value of 1104±116 mg.100 g^{-1}. Similar results were reported by Abd El-Aziz et al. (2014) from purslane samples in the area of Quisna city Minufiya, Egypt, where potassium and calcium contents were 4192 mg.100 g^{-1} and 1178 mg.100 g^{-1}, respectively. With an average value of 1282±143 mg.100 g^{-1}, magnesium takes 22% participation, with the highest value recorded in Area 7 – 1524 mg.100 g^{-1}, and the lowest one – 1142 mg.100 g^{-1} in Area 1. Regarding the sodium content, the minimum values obtained were 108 mg.100 g^{-1}, established in Area 7 and are almost three times less than the maximum values obtained, reaching up to 373 mg.100 g^{-1} reported in Area 4. The average value of this element is 208±100 mg.100 g^{-1}. Phosphorus content varied between 54 mg.100 g^{-1} and 95 mg.100 g^{-1}. Of all the studied elements, the least present was the element zinc, with an average value of 7.70±1.78 mg.100 g^{-1}. Much lower values were reported by Abd El-Aziz et al. (2014) – 1.90 mg.100 g^{-1}, and in fresh purslane samples Srivastava et al. (2021) reported zinc content of 0.17 mg.100 g^{-1} FW. Mohamed & Hussein (1994) studied purslane at different stages of its development (30, 49 and 59 days) and in its different parts (whole plant, leaves, stems and roots) in dry samples. The mineral composition in their research showed that for most mineral elements they do not have a direct dependence on the stage of development and content and also mineral elements migrate differently in different parts of the plant.

Antioxidant capacity

Portulaca oleracea L. has high antioxidant activity, phenolic compounds, flavonoids, vitamin C, etc. (Uddin et al., 2012; Petropoulos, 2016). RSC varies from 1.78 μmol TE.g^{-1} (DM) (Area 5) to 5.40 (Area 2) μmol TE.g^{-1} (DM), with an average value of 3.25±1.33 μmol TE.g^{-1} (DM). TFC in dry purslane samples are 175±17.07, mgCE.g^{-1}, with the lowest value of 142 mgCE.g^{-1} in Area 7, and the highest one – 200 mgCE.g^{-1} in Area 2. TPC are 21.69±6.04 mgGAE.g^{-1} (DM), and Abd El-Aziz (2014) reported 3.54 mgGAE.g^{-1} for TPC. According to the results obtained by us, the lowest values are for Area 7 - 12.07 mgGAE.g^{-1} (DM), and the highest ones - 28.97 mgGAE.g^{-1} (DM) (Area 2). Uddin et al. (2012) measured the antioxidant potential of purslane at different stages of development (at days 15, 30, 45 and 60). The authors found that total phenolic content on day 15 was significantly lower than on day 30, 45 and 60. Silva & Carvalho (2014) found that antioxidant activity and phenolic content were significantly higher in stems than in leaves and flowers. Ascorbic acid content in fresh *P. oleracea* L. Samples varied within wide limits from 8.86 mg.100g^{-1} (Area 5) to 20.66 mg.100g^{-1} (Area 4) with an average value of 15.38±5.00 mg.100g^{-1}, and according to USDA data, vitamin C content was 21 mg.100g^{-1}. Uddin et al. (2012) reported that ascorbic acid remained relatively constant at the different stages of purslane development. USDA reported that water content was 92.86%, which is slightly higher than the average result obtained by us – 88.27%±1.86, with the lowest value being in Area 4 – 87.23%, and the highest one in Area 6 – 90.64%. Total titratable organic acids varied from 0.14% (Area 5) to 0.26% (Area 3).

Table 3. Mineral composition of *P. oleracea* L. from the studied areas.

Number area	Ca, mg.100 g^{-1} (DM)	P, mg.100 g^{-1} (DM)	K, mg.100 g^{-1} (DM)	Mg, mg.100 g^{-1} (DM)	Na, mg.100 g^{-1} (DM)	Zn, mg.100 g^{-1} (DM)	Fe, mg.100 g^{-1} (DM)
Area 1	1073^{a}	80.80^{a}	3074^{a}	1142^{a}	233^{abc}	7.46^{a}	38.42^{a}
Area 2	982^{a}	62.25^{a}	2925^{a}	1256^{a}	152^{a}	5.68^{a}	53.73^{a}
Area 3	1187^{a}	65.25^{a}	3377^{a}	1143^{a}	143^{ab}	5.56^{a}	33.58^{a}
Area 4	1061^{a}	95.00^{a}	2079^{a}	1195^{a}	373^{c}	9.15^{a}	46.45^{a}
Area 5	1261^{a}	56.00^{a}	3880^{a}	1302^{a}	138^{ab}	8.66^{a}	70.75^{a}
Area 6	959^{a}	86.00^{a}	4048^{a}	1410^{a}	308^{b}	7.07^{a}	55.14^{a}
Area 7	1203^{a}	54.00^{a}	3172^{a}	1524^{a}	108^{a}	10.33^{a}	42.08^{a}
Min	959	54.00	2079	1142	108	5.56	33.58
Max	1261	95.00	4048	1524	373	10.33	70.75
Mean±SD	1104±116	71.33±15.92	3222±653	1282±143	208±100	7.70±1.78	48.59±12.49

*a-b different superscripts within the same column (for each parameter) represent significant differences at the level of significance P < 0.05, DM – dry matter

Table 4. Antioxidant activity and organic acids of *P. oleracea* L.

Number area	RSC, µmol TE.g^{-1} (DM)	TPC, mgGAE.g^{-1} (DM)	TFC, mgCE.g^{-1} (DM)	Vitamin C, mg.100g^{-1} (FW)	Total Titratable Organic Acids % (FW)	Dry matter, % (FW)	Water content, % (FW)
Area 1	4.54^{a}	26.31^{a}	180.75^{a}	17.72^{a}	0.24^{a}	12.768^{a}	87.23^{a}
Area 2	5.40^{a}	28.97^{a}	199.90^{a}	14.52^{a}	0.21^{a}	12.10^{a}	87.91^{a}
Area 3	3.46^{a}	23.72^{a}	173.83^{a}	20.17^{a}	0.26^{a}	10.86^{a}	89.15^{a}
Area 4	2.88^{a}	16.18^{a}	175.00^{a}	20.66^{a}	0.18^{a}	12.77^{a}	87.23^{a}
Area 5	1.78^{a}	25.46^{a}	175.59^{a}	8.86^{a}	0.14^{a}	12.5^{a}	87.48^{a}
Area 6	2.67^{a}	18.51^{a}	177.36	10.33^{a}	0.15^{a}	9.36^{a}	90.64^{a}
Area 7	1.99^{a}	12.07^{a}	142.01	-	-	-	-
Min	1.78	12.07	142.01	8.86	0.14	9.36	87.230
Max	5.40	28.97	199.90	20.66	0.26	12.77	90.64
Mean±SD	3.25±1.33	21.69±6.04	174.92±17.07	15.38±5.00	0.20±0.05	11.73±1.36	88.27±1.86

*RSC – radical scavenging capacity, TPS – total phenolic content, TFC – total flavonoids content, mgGAE.g^{-1} – mg as gallic acid equivalent, mgCE.g^{-1} – mg as catechin equivalent, µmol TE.g^{-1} – µmol as trolox equivalents , DM – dry matter, FW – fresh weigh.

Statistics

The Pearson coefficient correlation matrix obtained between TPC and TFC demonstrates a very strong relationship (Table 5). The correlation coefficient was positive with a value of 0.94 because flavonoid content increased with increasing of the phenolic content. This is understandable since flavonoids belong to the polyphenol family. The dependence between RSC, µmol TE.g^{-1} (DM), on the one hand, TPC, mgGAE.g^{-1} DM and TPC, mgGAE.g^{-1} DM, on the other, was calculated to be 0.86 and 0.73, respectively. An interesting negative relationship was observed between phosphorus content and total phenols R = -0.66, as well as a negative relationship between total flavornoids and calcium content, R = -0.65. A strong negative relationship was observed in the nutriational composition between crude protein and crude fiber, with a correlation coefficient value of R = - 0.83.

Table 6 shows the required daily doses for an adult of some of the micro and macro elements in the composition of purslane, and for some of them (Mg, K and Fe) the amounts are several times higher than the indicated recommended daily doses or close to them. According to our research, the above-ground parts of purslane could be used as a nutritious and useful food with a low caloric content - 304.79±9.88, kcal.100.g^{-1} and fat - 4.62±0.88%, rich in carbohydrates - 43.14±2.37 mg.100g^{-1} and rich in vegetable proteins – 22.66±2.98%. Along with our studies, there are

also many that prove or suggest numerous pharmacological effects, some of them being significant antioxidant activity of phenolic compounds, therefore purslane could be used in the production of functional foods or considered in itself as such (Naciye, 2012). Purslane has the highest vitamin A content among green leafy vegetables, which is a natural antioxidant, as well as vitamin C, alpha-tocopherol, beta-carotene and glutathione and omega-3 fatty acids, known for their healing and antimicrobial effects, which is confirmed by its traditional use in topical treatment of inflammatory conditions (Uddin et al., 2014). Other benefits of omega 3 fatty acids are that they protect from heart attacks and heart problems (Bown, 1995). Burkill (1997) found that the substance levartenol increased blood pressure and decreased heart rate and strengthened the immune system. Isoflavonoids isolated from above-ground parts of tunica show strong anticancer activity against human cancer cell line SGC-7901 with 1.6 µg/ml IC50 value (Tian et al., 2014). A study by El-Sayed (2011) suggested that the seeds of *P. oleracea* possess antidiabetic and hypolipidemic activity and can be used as an alternative drug in type 2 diabetes. Nadkarni & Nadkarni (1999) believed that responsible for antidiabetic activity, is a polysaccharide in *P. oleracea*. Scientists from China have found a lowering of blood sugar in diabetic mice but has not been observed in healthy mice (Cui et al., 2005).

Table 5. Pearson coefficient of studies chemical components of *P. oleracea* L.

Variables	RSC, µmol TE.g^{-1} (DM)	TPC, mgGAE.g^{-1} (DM)	TFC, mgCE.g^{-1} (DM)	Crude protein, % (DM)	Crude fat, % (DM)	Crude fibre, % (DM)	NFE, % (DM)	Ca, mg.100g^{-1} (DM)	P, mg.100g^{-1} (DM)	Na, mg.100g^{-1} (DM)	Vit. C, mg.100g^{-1} (FW)	Organic Acids % (FW)
RSC, µmol TE/g (DM)	**1.00**	**0.83**	**0.76**									
TPC, mgGAE/g (DM)	**0.83**	**1.00**	**0.94**									
TFC, mgCE/g (DM)	**0.76**	**0.94**	**1.00**									
Crude protein, % (DM)	-0.29	-0.50	-0.26	**1.00**								
Crude fat, % (DM)	0.11	0.21	0.03	-0.26	**1.00**							
Crude fibre, %(DM)	-0.08	0.33	0.17	**-0.83**	0.21	**1.00**						
NFE, % (DM)	0.47	0.47	0.27	**-0.69**	-0.04	0.36	**1.00**					
Ca, mg/100g (DM)	-0.61	-0.52	**-0.65**	-0.15	0.05	0.32	0.23	**1.00**				
P, mg/100g (DM)	-0.35	**-0.66**	-0.57	**0.74**	-0.18	**-0.66**	**-0.67**	0.07	**1.00**			
Na, mg/100g (DM)	-0.35	-0.52	-0.40	0.63	-0.48	-0.40	-0.40	0.26	**0.77**	**1.00**		
Vitamin C, mg %(FW)	-0.04	-0.22	-0.31	0.23	0.43	-0.31	-0.22	0.32	0.55	0.23	**1.00**	
Organic acid, %(FW)	0.24	0.09	-0.05	0.11	**0.69**	-0.33	0.01	0.10	0.24	-0.13	**0.82**	**1.00**

Table 6. Mineral content of *P. oleracea* and recommended daily intake in adults

Components	Average values of dried powder of *P. oleracea*	*Recommended daily intake (adult), mg/day
Calcium (Ca), mg.100 g^{-1}	1103.67±115.60	1200
Sodium (Na), mg.100 g^{-1}	207.66±100.21	1600
Potassium (K), mg.100 g^{-1}	3222.10±652.87	1650 - 1875
Magnesium (Mg), mg.100 g^{-1}	1281.74±143.02	270 - 400
Iron (Fe), mg.100 g^{-1}	48.59±12.49	12 - 15
Zinc (Zn), mg.100 g^{-1}	7.70±1.78	12 - 15
Energy, kcal.100 g^{-1}	304.79±9.88	-
Carbohydrates, g.100 g^{-1}	43.14±2.37	-
Bread units	3.59±0.25	-

*Daily requirement of adult (Food and Nutrition Board, 1989)

Antimycotic activity of extracts of tuculacea has been found in some strains of the genus Trichophyton (Oh et al., 2000). Elkhayat et al. (2008) by chromatographic analysis of chloroform extract of tunica in Egypt identified a new clerogenic diterpene, portolene, and was administered to rats with liver damage as 70% alcohol extract of *P. oleracea* and the treatment was shown to significantly restore liver marker enzymes and total bilirubin to near normal values, demonstrating hepatoprotective activity. In addition, the extract also showed antifungal activity as well as significant broad-spectrum antibacterial activity. Use in cosmetics - fresh juice and decoction are used topically due to its antimicrobial, anti-inflammatory and healing action (Leung & Foster, 1996) 2010) and many other beneficial properties.

Conclusions

Common purslane is found in various soils from acidic to alkaline reaction, in places where there are gaps in pavements or asphalt, it grows well and this does not lead to a change in the chemical, biochemical and mineral composition. The wild purslane remains rich in antioxidants, known for their beneficial effects on the body. High nutritional value with low fat and calorie content and satisfying the daily needs of micro and macro elements. Our research findings, as well as those of other scientists around the world, describe purslane as a cheap, unpretentious and easy-to-grow resource for the pharmaceutical, cosmetic, food and livestock industries. That is why purslane should stop being seen as an unnecessary weed, as it is known in Bulgaria, and should be perceived as a useful, nutritious and even necessary medicinal food or, in short, functional food. In future research and studies, it could also be considered a potential fodder crop being grown on infertile soils without reducing its beneficial, nutritional and medicinal properties.

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