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The Bioactivities and Chemical Profile of Turnip-Rooted Parsley Germplasm

Spyridon A. Petropoulos [1], Ângela Fernandes [2,*], Tiane C. Finimundy [2], Nikolaos Polyzos [1], José Pinela [2], Marija Ivanov [3], Marina Soković [3], Isabel C. F. R. Ferreira [2] and Lillian Barros [2,*]

[1] Department of Agriculture Crop Production and Rural Environment, University of Thessaly, 38446 Volos, Greece; spetropoulos@uth.gr (S.A.P.); npolyzos@uth.gr (N.P.)
[2] Centro de Investigação de Montanha (CIMO), Instituto Politécnico de Bragança, Campus de Santa Apolónia, 5300-253 Bragança, Portugal; tiane@ipb.pt (T.C.F.); jpinela@ipb.pt (J.P.); iferreira@ipb.pt (I.C.F.R.F.)
[3] Department of Plant Physiology, Institute for Biological Research "Siniša Stanković"—National Institute of Republic of Serbia, University of Belgrade, Bulevar Despota Stefana 142, 11000 Belgrade, Serbia; marija.smiljkovic@ibiss.bg.ac.rs (M.I.); mris@ibiss.bg.ac.rs (M.S.)
* Correspondence: afeitor@ipb.pt (Â.F.); lillian@ipb.pt (L.B.); Tel.: +351-273330904 (L.B.)

Abstract: In the present study, the chemical profile and bioactive properties of the roots of turnip-rooted parsley (*Petroselinum crispum* spp. *tuberosum*) germplasm were evaluated. For this purpose, plants from seventeen parsley cultivars were grown in 6 L pots, and the obtained roots were analyzed in terms of nutritional value, chemical composition (tocopherols, sugars and organic and fatty acids) and bioactive content (antioxidant activity, phenolic compound composition and antimicrobial properties). Our results showed great variability in terms of the chemical composition and bioactive properties of root parsley germplasm. A higher fresh root yield was recorded for the common "Root parsley" common variety (164 g/pot), followed by the varieties "Osborne" (109 g/pot), "Sonata" (104 g/pot), "Kaśka" (104 g/pot) and "Halblange Berlinska" (103 g/pot), whereas the lowest yield was recorded for the "Hanacka" variety (69 g/pot). A significant variation was also observed in the nutritional value parameters: the roots of the "Sonata" genotype showed the highest fat content; "Arat", "Osborne" and "Olomuńcka" had the highest ash content; the "Alba" cultivar contained significantly higher amounts of carbohydrates; and the "Vistula" cultivar showed the highest energetic value. The only detected isoforms of vitamin E were α- and δ-tocopherols; content varied depending on the cultivar, although α-tocopherol was the most abundant compound in most cultivars, especially in the "Arat" cultivar. Sucrose was the most abundant free sugar detected, especially in the "Sonata" cultivar (16.96 g/100 g dw), followed by apiose (2.93–5.55 g/100 g dw), glucose (1.3–3.47 g/100 g dw) and fructose (1.37–3.03 g/100 g dw). Moreover, malic acid was the most abundant organic acid in most of the tested cultivars. Twenty-one individual fatty acids were identified in all the studied cultivars, with linoleic (47.9–57.1%) and palmitic acid (20.66–20.5%) being the most abundant. Nineteen individual phenolic compounds were tentatively identified, including three phenolic acids, fourteen flavonoids and two hydrolyzable tannins, while apigenin-O-pentoside-O-hexoside was the most abundant. The antioxidant activity differed between the tested assays (TBARS and OxHLIA), and the most effective cultivars for the TBARS assay ("Root parsley (common variety)" and "Berlinski Halblange Springer") were those with the lowest antioxidant activity for the OxHLIA assay after 120 min. Finally, in most cases, the root extracts were more efficient or similarly effective compared to the positive controls against the tested bacteria and fungi. In conclusion, our results provide information regarding the chemical characterization and the bioactivities of the roots of turnip-rooted parsley germplasm that could be further exploited in sustainable and diversified agro-ecosystems through the introduction of this species as a novel/complementary crop in the traditional farming systems of the Mediterranean basin.

Keywords: *Petroselinum crispum* spp. *tuberosum*; turnip-rooted parsley; "Hamburg type" parsley; phenolic compounds; organic acids; antimicrobial properties; antioxidant activity

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1. Introduction

Petroselinum crispum (Mill.) Fuss is a biennial cultivated plant commonly known as parsley that belongs to the family Apiaceae or Umbellliferae and the genus *Petroselinum* [1]. The Mediterranean region, and more precisely Sardinia, has been recognized as its primary center of origin, whereas its cultivation dates back to the 3rd century BC [2]. Parsley can be divided into three main types, namely the plain-leaf type (*Petroselinum crispmum* ssp. *neapolitanum*, Danert), the curly-leaf type (*Petroselinum crispum* ssp. *crispum*) that is mainly cultivated for its aromatic foliage and, lastly, the turnip-rooted or 'Hamburg' type (*Petroselinum crispum* ssp. *tuberosum*) cultivated for its fleshy taproots [3]. It is widely cultivated as an annual species throughout the world, while the fresh and dried herbs of the plant are widely used for flavoring and garnishing in many food products due to the characteristic aroma [4]. Similarly, the essential oils and oleoresins from the aerial plant parts are widely exploited in perfume manufacturing as fragrances, as well as in traditional and folk medicine [4–6]. In particular, the aerial parts of parsley have been associated with several health effects and have been used since ancient times for the treatment of hemorrhoids, gastrointestinal disorders, blurred vision and urinary tract and skin diseases, whereas extracts of parsley have been associated with antidiabetic, antihypertensive, spasmolytic, antibacterial, antifungal, analgesic and immunosuppressant activities [6–8].

The aerial plant parts of parsley, such as the stems, leaves, fruits and seeds, are the most commonly used and considered a rich source of polyphenols, carotenoids, furanocoumarins, essential oils, minerals and fatty acid compounds, as well as vitamins such as tocopherols, B complex, A and C [9–14]. On the other hand, turnip-rooted parsley is appreciated for its edible fleshy roots that contain essential oils [3,15,16], as well as iron and polyphenols [17], vitamin C [13], carotenoids [18] and flavonoids [19]. In contrast, according to the literature, the consumption of parsley roots may be associated with health risks related to nitrate intake depending on the cultivation system (organic vs. conventional cropping), the genotype and the time of harvest, which may also affect nitrate content [20–22]. However, Pokluda [23] suggested that the nitrate content of 15 root parsley cultivars was within tolerance limits. Moreover, in the study by Kolarovic et al. [24], it was suggested that parsley root juice might show protective effects against doxorubicin-induced cardiotoxicity. Crop diversification in the Mediterranean basin, through the introduction of new species and/or cultivars of conventional crops, is imminent due to the severe effects of climate change and the increasing need for genotypes better adapted to the new conditions [25]. The Apiaceae family includes several aromatic and medicinal plants and shows great genetic diversity that could be further exploited with the aim of improving the agro-biodiversity of the region [25,26]. Our previous experiments, where various parsley cultivars of all three types were evaluated, showed promising results regarding the fresh herb and root yield, the chemical composition and the bioactive compound content of the aerial parts of the plant [27–29]. In this follow-up study, several turnip-rooted parsley cultivars were evaluated for their yield potential, as well as for the existence of variability in the chemical composition and bioactive properties of parsley germplasm.

2. Materials and Methods

2.1. Plant Material and Growing Conditions

Seeds from 17 different cultivars of turnip-rooted parsley (*Petroselinum crispum* spp. *tuberosum*) were directly sown on 7–8 November 2018 in 6 L plastic containers containing peat (Klassman-Deilmann KTS2, Klasmann-Deilmann GmbH, Geeste, Germany) and perlite (1:1; *v*/*v*). The complete list of the names of the cultivars and the growing conditions was already described by Liberal et al. [27] and Fernandes et al. [28]. In brief, after emergence, the young seedlings were thinned to three plants per container with equal distances, while 15 pots were used for each cultivar. The experiment took place in an unheated greenhouse at the experimental farm of the University of Thessaly in Velestino, Greece. Throughout the cultivation period, plants were irrigated once or twice a week via a sprinkler irrigation

system, whereas fertigation was implemented manually twice a month with a nutrient solution containing 200 mg/L of N–P–K (Atlas 20-20-20 + TE, Gavriel S.A., Volos, Greece) in amounts ranging between 150 and 300 mL per pot depending on the growth stage of the plants and the environmental conditions. Pest and disease control was carried out based on the best practices recommended for parsley. The plants were harvested on 12 June 2019, which was towards the end of the growing cycle and when the leaves had started to wither and the roots had obtained a marketable size. After harvest, the fresh weight of the roots was calculated, while batch samples of the roots of each cultivar were put in air-sealed bags in freezing conditions for the determination of nutritional value, chemical composition and bioactive compounds.

2.2. Chemical Analysis

2.2.1. Nutritional and Energetic Compound Determination

Samples of fresh roots were stored at deep freezing conditions (−80 °C) and later freeze-dried before the chemical composition analysis. The determination of the nutritional and energetic values was carried out according to the procedures described by the Association of Official Analytical Chemists [30]. The crude fat content was estimated using a Soxhlet apparatus (Behr Labor Technik, Dussedolf, Germany) by extraction with petroleum ether. The protein content was determined according to the macro-Kjeldahl method (N × 6.25) using an automatic distillation and titration unit (model Pro-Nitro-A, JP Selecta, Barcelona, Spain) and the ash composition of the samples was evaluated by incineration at 600 ± 15 °C. The total carbohydrate content was evaluated by the difference based on the following equation: total carbohydrates (g/100 g dry weight (dw)) = 100 − (g fat + g ash + g protein). Lastly, the energetic values were estimated according to the Atwater system using the following equation: energy (kcal/100 g dw) = 4 × (g protein + g carbohydrate) + 9 × (g fat).

2.2.2. Tocopherol Composition

Lyophilized samples were used to determine the tocopherol composition according to the procedures described by Spréa et al. [31]. A high-performance liquid chromatography system (HPLC, Knauer, Smartline system 1000, Berlin, Germany) combined with a fluorescence detector (FP-2020; Jasco, Easton, PA, USA) programmed at 290 nm and 330 nm using the internal standard (IS, tocol, Matreya, Pleasant Gap, PA, USA) method was used for the separation and quantification of the compounds. Quantification was carried out based on the fluorescence signal response of each standard, whereas the identification of the samples was performed using authentic standards. The results were expressed in mg/100 g (dw).

2.2.3. Free Sugar Composition

The free sugar composition of the extracted lyophilized samples was determined according to the methodology reported by Spréa et al. [31]. The separation of the free sugars was performed by the HPLC mentioned above coupled with a refraction index detector (Knauer Smartline 2300, Berlin, Germany). After separation, the free sugar compounds were identified by comparison with standards, and quantification was carried out according to the IS method (melezitose). Raw data were processed through the Clarity 2.4 software package (DataApex, Prague, Czech Republic) and expressed in g per 100 g of dw.

2.2.4. Organic Acid Composition

According to the procedures described by Pereira et al. [32], the organic acid composition was determined using ultra-high-performance liquid chromatography coupled with a diode array detector (UHPLC–DAD, Shimadzu 20A series UHPLC, Shimadzu Corporation, Kyoto, Japan) to detect the absorption in the UV to VIS region. After the identification of the compounds, they were quantified by comparing the retention times, spectra and peak areas recorded at 215 nm and 280 nm based on the commercial standards. Results were processed using LabSolutions Multi LC-PDA software (Shimadzu Corporation, Kyoto, Japan) and were expressed in g/100 dw.

2.2.5. Fatty Acid Composition

Lyophilized samples were used to evaluate the fatty acid composition using gas–liquid chromatography with flame ionization detection (YOUNG IN Chromass 6500 GC System, YL Instruments, Anyang, Korea) based on the methodology reported by Spréa et al. [31] after *trans*-esterification of the lipid fraction attained by Soxhlet extraction. The identification and quantification were determined by comparing the relative retention times of the fatty acid methyl ester (FAME) peaks of the samples with commercial standards (FAMEs, reference standard mixture 37, Sigma-Aldrich, St. Louis, MO, USA). The results recorded were processed using CSW 4.0 Software (Informer Technologies, Inc., Solihull, UK) and were expressed as the relative percentage for each detected fatty acid compound.

2.3. Polyphenolic Profile Characterization

2.3.1. Preparation of Hydroethanolic Extracts

The samples were used to make hydroethanolic extracts by stirring the plant material (~2.5 g) with 30 mL of ethanol/water (80:20, *v*/*v*) at 25 °C for 1 h and filtering through Whatman No. 4 paper. The deposit was then re-extracted with an extra 30 mL of the hydroalcoholic mixture. The joint extracts were concentrated at 40 °C under reduced pressure (rotary evaporator Büchi R-210, Flawil, Switzerland) and further lyophilized (FreeZone 4.5, Labconco, Kansas City, MO, USA).

2.3.2. Phenolic Compounds

Phenolic compounds were investigated in the hydroethanolic extracts prepared above, which were redissolved in ethanol/water (80:20, *v*/*v*) to a final concentration of 10 mg/mL and filtered through 0.22-µm disposable filter disks. Phenolic compounds were determined using an ultra-performance liquid chromatography (UPLC) system coupled with a diode array detector at 280 nm, 330 nm and 370 nm and equipped with an electrospray ionization mass spectrometry detector (MS) (Dionex Ultimate 3000 UPLC and Linear Ion Trap LTQ XL, Thermo Scientific, San Jose, CA, USA). The identification of the phenolic compounds was carried out by a comparison of the retention times, UV–VIS signals and mass spectra of the sample compounds with those obtained from the available standards, as well as with the data reported in the literature, and they were tentatively identified using the fragmentation pattern. The evaluation of phenolic compounds was performed using the calibration curves obtained from standards that were constructed based on their UV–VIS signals. The most similar structural compound available in the literature was used to perform the quantification in the case of a non-available standard compound [33]. A manual integration using the baseline-to-valley information mode with baseline projection was performed to obtain the area of the peaks. The results were expressed in mg/g extract.

2.4. Antioxidant Activity Evaluation

The antioxidant activity was evaluated in the hydroethanolic extracts prepared above through two cell-based assays: the thiobarbituric acid reactive substances (TBARS) assay and the oxidative haemolysis (OxHLIA) assay, based on the procedures described by Lockowandt et al. [34]. For the TBARS assay, the hydroethanolic extracts were redissolved in water and subjected to dilutions from 10 mg/mL to 0.3125 mg/mL. The lipid peroxidation inhibition in porcine (*Sus scrofa*) brain cell homogenates was evaluated by the decrease in TBARS and the color intensity of the malondialdehyde–thiobarbituric acid (MDA–TBA) by measuring its absorbance at 532 nm. The inhibition ratio (%) was considered using the formula $[(A - B)/A] \times 100\%$, where A and B correspond to the absorbance of the control and extract samples, respectively. The results were expressed in EC_{50} values (mg/mL), representing the sample concentration that provides 50% antioxidant activity. Trolox (Sigma-Aldrich, St. Louis, MO, USA) was used as a positive control. The antihaemolytic activity of the extracts was evaluated through the OxHLIA assay using red blood cells (RBCs) isolated from healthy sheep as previously described [34]. An erythrocyte solution (2.8%, *v*/*v*; 200 µL) was mixed with 400 µL of either extract solution (0.0938–3 mg/mL PBS),

PBS (control) or water (for complete hemolysis). After pre-incubation at 37 °C for 10 min with shaking, AAPH was added (200 µL, 160 mM in PBS, from Sigma-Aldrich, St Louis, MO, USA) and the optical density was measured at 690 nm every ~10 min in a microplate reader (Bio-Tek Instruments, ELX800, Santa Clara, CA, USA) until complete hemolysis. The results were expressed as IC_{50} values (µg/mL) at Δt of 60 and 120 min, corresponding to the extract concentration required to protect 50% of the erythrocyte population from the hemolytic action. Trolox was also used as a positive control.

2.5. Antimicrobial Activity Evaluation

The levels of antimicrobial and antifungal activity were determined in the hydroethanolic extracts prepared above through a microdilution method according to the methodology reported by Finimundy et al. [35]. The Gram-positive bacteria used for the assessment of the antibacterial properties were *Staphylococcus aureus*, *Bacillus cereus* (food isolate), *Escherichia coli*, *Salmonella typhimurium* and *Enterobacter cloacae*. Regarding the determination of the antifungal activity, six micromycetes were used, namely *Aspergillus fumigatus*, *A. niger*, *A. versicolor*, *Penicillium funiculosum*, *Trichoderma viride* and *P. verrucosum* var. *cyclopium* (food isolate). The minimum inhibitory, bactericidal and fungicidal concentrations (MICs, MBCs and MFCs, respectively) were assessed using the serial dilution technique in 96-well microtiter plates (ThermoFisher Scientific, Lisbon, Portugal). Two positive controls were used, namely E211 and E224 (Sigma-Aldrich, St. Louis, MO, USA).

2.6. Statistical Analysis

Regarding the yield analysis of the roots, the yield of each pot was regarded as an experimental unit (n = 15) and data were analyzed using one-way ANOVA (SPSS Statistics software, IBM SPSS Statistics for Windows, Version 22.0, IBM Corp., Armonk, NY, USA). For the determination of chemical composition and bioactive properties, three independent samples were used and analyzed in triplicate from each studied genotype of parsley. The results were expressed as mean ± standard deviations. Statistical analysis was performed at a 5% significance level using SPSS statistics software. Before the ANOVA analysis, all samples were tested for normal distribution according to the Shapiro–Wilk test and Levene's test, whereas the comparison of means was carried out with Tukey's HSD test ($p < 0.05$) when statistically significant differences were detected.

3. Results and Discussion

The results of the root yield analysis of the studied turnip-rooted parsley varieties are presented in Table 1. A significant variation in fresh yield was recorded among the genotypes, with the best performance being observed for the common "Root parsley" variety (164 g/pot), followed by the varieties "Osborne" (109 g/plot), "Sonata" (104 g/pot), "Kaśka" (104 g/pot) and "Halblange Berlinska" (103 g/pot), whereas the lowest yield was recorded for the "Hanacka" variety (69 g/pot). A similar variability in the yield of root parsley germplasms was recorded by Pokluda et al. [23], Rahimić et al. [36] and Petropoulos et al. [29], who suggested significant differences between root parsley cultivars, as well as by Fernandes et al. [28], who evaluated the fresh foliage yield of the same cultivars as in the present study and recorded genotypic differences. The observed differences may be attributed to genotypic differences, as well as differences in the length of the growth cycle of each cultivar, which suggests the application of different sowing dates to facilitate the best performance of each genotype [29]. Moreover, considering that most of these genotypes are cultivated in northern Europe, this probably suggests an adaptation to cooler climates than those of the south Mediterranean that could be overcome through the selection of suitable growing sites and corresponding growing periods.

Table 1. Fresh weight (g/pot; mean ± SD, *n* = 15), nutritional value (g/100 g dw) and energetic value (kcal/100 g dw) of roots of the studied turnip-rooted parsley cultivars (mean ± SD, *n* = 3).

Cultivar	Root Yield (g/pot)	Fat	Protein	Ash	Carbohydrate	Energy
Olomuńcka	86 ± 3 e	1.92 ± 0.01 d	6.18 ± 0.02 bcd	5.54 ± 0.09 a	86.36 ± 0.07 k	387.4 ± 0.3 i
Pólna	83 ± 3 e	1.84 ± 0.03 de	5.93 ± 0.07 ef	4.80 ± 0.08 ef	87.42 ± 0.08 g	390.0 ± 0.3 g
Linga	95 ± 4 c	1.40 ± 0.06 h	6.06 ± 0.09 cde	5.17 ± 0.04 b	87.37 ± 0.01 gh	386.3 ± 0.1 jk
Halblange Berlinska	103 ± 3 b	2.02 ± 0.07 c	5.02 ± 0.07	4.58 ± 0.06 g	88.38 ± 0.04 d	391.8 ± 0.1 de
Osborne	109 ± 6 b	1.76 ± 0.06 f	6.23 ± 0.09 b	5.56 ± 0.09 a	86.45 ± 0.09 k	386.5 ± 0.5 j
Lenka	78 ± 4 f	2.04 ± 0.01 c	5.51 ± 0.09 f	4.62 ± 0.09 g	87.8 ± 0.1 f	391.7 ± 0.3 de
Sonata	104 ± 8 b	2.60 ± 0.01 a	6.20 ± 0.02 bc	4.89 ± 0.09 de	86.31 ± 0.09 k	393.4 ± 0.2 b
Kaśka	104 ± 9 b	2.29 ± 0.02 b	5.88 ± 0.09	4.68 ± 0.02 fg	87.15 ± 0.07 i	392.7 ± 0.1 bc
Vistula	95 ± 7 c	2.26 ± 0.07 b	5.18 ± 0.05 g	4.23 ± 0.07 h	88.34 ± 0.05 de	394.4 ± 0.4 a
Konika	93 ± 6 cd	1.83 ± 0.04 ef	5.27 ± 0.03 g	4.19 ± 0.06 h	88.71 ± 0.05 c	392.4 ± 0.1 cd
Hanacka	69 ± 10 g	1.89 ± 0.02 de	6.04 ± 0.05 de	5.06 ± 0.09 bc	87.01 ± 0.04 i	389.2 ± 0.2 h
Halblange Eagle	77 ± 3 f	1.92 ± 0.03 d	5.22 ± 0.05 g	4.69 ± 0.05 fg	88.18 ± 0.02 e	390.8 ± 0.1 f
Cukrowa	77 ± 3 f	1.63 ± 0.01 g	4.78 ± 0.06 i	4.18 ± 0.04 h	89.41 ± 0.02 b	391.4 ± 0.2 ef
Alba	89 ± 5 de	0.78 ± 0.01 i	4.84 ± 0.07 i	4.54 ± 0.05 g	89.84 ± 0.03 a	385.7 ± 0.2 k
Arat	91 ± 3 cd	0.73 ± 0.01 i	6.56 ± 0.05 a	5.51 ± 0.06 a	87.20 ± 0.01 hi	381.6 ± 0.2 m
Root parsley (Common variety)	164 ± 4 a	0.62 ± 0.01 j	6.15 ± 0.09 bcd	4.96 ± 0.05 cd	88.27 ± 0.03 de	383.3 ± 0.2 l
Berlinski Halblange Springer	89 ± 3 cd	0.51 ± 0.02 k	6.14 ± 0.08 bcd	4.95 ± 0.07 cde	88.4 ± 0.1 d	382.7 ± 0.3 l

Means followed by different Latin letters in the same column are significantly different according to Tukey's HSD test ($p = 0.05$).

The nutritional values of the studied parsley germplasms are presented in Table 1. Significant variations were recorded for all the determined parameters, with the roots of the "Sonata" genotype showing the highest fat content and "Berlinski Halblange Springer" the lowest. On the other hand, the roots of the "Arat" cultivar were the richest in protein, whereas "Cucrowa" and "Alba" contained the lowest amount of protein. "Arat", "Osborne" and "Olomuńcka" had the highest ash content, with no significant differences between them, whereas "Vistula", "Konika" and "Cucrowa" had the lowest amounts of ash. The "Alba" cultivar contained significantly higher amounts of carbohydrate than the rest of the tested genotypes, whereas the carbohydrate contents in the "Olomuńcka", "Osborne" and "Sonata" roots were the lowest overall. Finally, the "Vistula" and "Arat" cultivars showed the highest and lowest energetic value among the tested genotypes, respectively. To the best of our knowledge, this is the first report regarding the nutritional value of turnip-rooted parsley roots. However, similar variations were observed in the nutritional value of the leaves of the same turnip-rooted parsley cultivars by our team [28], while Pokluda et al. [23] suggested a varied composition of minerals in various root parsley cultivars. Moreover, Dobričević et al. [13] and Golubkina et al. [36] reported a great variation in the total soluble solid content of the roots and seeds, respectively, of various parsley types (e.g., plain- and curly-leaf and turnip-rooted parsley), which could be associated with differences in proximate analysis parameters. Finally, Pokluda [37] suggested a great variation in the dry matter content of root parsley cultivars, indicating differences in the parameters that constitute the nutritional value.

The composition of tocopherols in the roots of the studied germplasms is presented in Table 2. The only detected isoforms of vitamin E were α- and δ-tocopherols, which showed variable content levels depending on the cultivar. Therefore, although in most cultivars α-tocopherol was the most abundant compound, there were also genotypes, such as "Pólna", "Linga", "Alba", "Arat" and "Root parsley", where similar amounts of both tocopherols were detected. Regarding the variation among the tested cultivars, "Arat" roots were the richest in α- and total tocopherols; the same cultivar, as well as "Pólna" and "Root parsley", had the highest levels of δ-tocopherol. A-tocopherol was previously reported in parsley roots by Horbowicz [38], while Gómez-Coronado [39] and Fernandes et al. [28] suggested α- and γ-tocopherol as the only detected vitamin E vitamers in parsley leaves. In contrast, Saleh et al. [40] identified all tocopherols in parsley aerial parts, with α-tocopherol being the most abundant isoform. However, apart from genotypic effects,

growing conditions, such as red light dose, wavelength and pressure from stress factors, may also affect tocopherol composition [41,42].

Table 2. Composition of tocopherols in the roots of the studied turnip-rooted parsley genotypes (mg/100 g dw) (mean ± SD, n = 3).

Cultivar	α-Tocopherol	δ-Tocopherol	Total Tocopherols
Olomuńcka	1.55 ± 0.05 f	0.69 ± 0.01 gh	2.25 ± 0.05 i
Pólna	2.19 ± 0.05 b	2.05 ± 0.02 a	4.25 ± 0.04 b
Linga	1.38 ± 0.04 gh	1.60 ± 0.05 b	2.99 ± 0.09 c
Halblange Berlinska	1.76 ± 0.01 de	0.66 ± 0.01 h	2.41 ± 0.01 fg
Osborne	1.26 ± 0.02 j	1.04 ± 0.03 de	2.31 ± 0.05 hi
Lenka	1.10 ± 0.01 k	0.93 ± 0.01 f	2.04 ± 0.01 j
Sonata	1.82 ± 0.01 d	0.67 ± 0.02 h	2.49 ± 0.01 ef
Kaśka	1.74 ± 0.01 e	0.92 ± 0.02 f	2.66 ± 0.03 d
Vistula	1.38 ± 0.01 gh	0.98 ± 0.08 ef	2.36 ± 0.06 gh
Konika	1.29 ± 0.03 ij	0.76 ± 0.03 g	2.04 ± 0.01 j
Hanacka	1.79 ± 0.05 de	0.75 ± 0.01 gh	2.54 ± 0.05 e
Halblange Eagle	1.42 ± 0.01 g	0.89 ± 0.01 f	2.31 ± 0.02 hi
Cukrowa	1.88 ± 0.02 c	1.12 ± 0.02 cd	3.00 ± 0.04 c
Alba	1.33 ± 0.01 hi	1.17 ± 0.05 c	2.51 ± 0.04 ef
Arat	2.58 ± 0.01 a	2.05 ± 0.06 a	4.63 ± 0.07 a
Root parsley (Common variety)	2.18 ± 0.02 b	2.05 ± 0.09 a	4.23 ± 0.07 b
Berlinski Halblange Springer	1.40 ± 0.01 g	1.08 ± 0.02 d	2.48 ± 0.02 ef

Tocopherol calibration curves: α-tocopherol (y = 1.295x; R^2 = 0.991; lower limit of detection (LLOD): 18.06 ng/mL; lower limit of quantification (LLOQ): 60.20 ng/mL) and δ-tocopherol (y = 0.678x; R^2 = 0.992; LLOD = 20.09 ng/mL; LLOQ = 66.95 ng/mL). Means followed by different Latin letters in the same column are significantly different according to Tukey's HSD test (p = 0.05).

The composition of free sugars in the roots of the studied parsley germplasms is presented in Table 3. Four individual free sugars were detected, with sucrose being the most abundant compound (13.53–16.96 g/100 g dw), followed by apiose (2.93–5.55 g/100 g dw), glucose (1.3–3.47 g/100 g dw) and fructose (1.37–3.03 g/100 g dw). The "Sonata" cultivar had the highest sucrose content, while "Olomuńcka", "Arat" and "Root parsley" were the richest in apiose; "Pólna" and "Kaśka" were the most abundant in glucose, and "Pólna" "Lenka", "Kaśka" and "Cucrowa" contained the highest amounts of fructose. In contrast, the lowest sucrose content was detected in the "Osborne" and "Vistula" cultivars, while apiose and glucose levels were the lowest in "Berlinski Halblange Springer" and that of fructose was lowest in the "Osborne" cultivar. Finally, the highest and lowest total sugar contents were recorded in the "Kaśka" and "Berlinski Halblange Springer" cultivars, respectively. The same compounds constitute the free sugars identified in parsley leaves following a genotype-dependent composition pattern [28], while Tkacz et al. [43] also identified rhamnose but not apiose in a sea-buckthorn-based smoothie that contained the pulp of parsley roots. In contrast, in an early study by Horbowjcz et al. [44], only sucrose, mannitol, raffinose and traces of fructose and glucose were detected, a difference which may be attributable to different protocols and analytical equipment. Apiose was identified in parsley in very early studies during the first half of the 20th century and is typical of the *Apium* genus and species such as celery and parsley [45].

Table 3. Composition of free sugars in the roots of the studied turnip-rooted parsley cultivars (g/100 g dw) (mean ± SD, $n = 3$).

Cultivar	Apiose	Fructose	Glucose	Sucrose	Total Free Sugars
Olomuńcka	5.52 ± 0.03 a	2.52 ± 0.04 d	2.41 ± 0.04 h	15.50 ± 0.05 c	25.95 ± 0.08 d
Pólna	4.80 ± 0.05 c	3.00 ± 0.04 a	3.47 ± 0.05 a	15.00 ± 0.06 f	26.3 ± 0.1 c
Linga	3.97 ± 0.01 h	2.62 ± 0.05 bc	2.84 ± 0.01 cdef	15.12 ± 0.03 e	24.55 ± 0.07 f
Halblange Berlinska	3.96 ± 0.04 h	2.66 ± 0.03 b	3.03 ± 0.03 c	15.59 ± 0.06 c	25.2 ± 0.1 e
Osborne	3.48 ± 0.03 j	1.37 ± 0.06 i	2.80 ± 0.03 def	13.53 ± 0.01 j	21.18 ± 0.02 i
Lenka	4.47 ± 0.05 d	3.02 ± 0.07 a	2.88 ± 0.02 cdef	16.52 ± 0.04 b	26.9 ± 0.1 b
Sonata	4.53 ± 0.04 d	2.16 ± 0.01 f	2.73 ± 0.01 fg	16.96 ± 0.07 a	26.37 ± 0.08 c
Kaśka	5.02 ± 0.03 b	3.03 ± 0.06 a	3.26 ± 0.02 ab	16.52 ± 0.07 b	27.82 ± 0.08 a
Vistula	3.97 ± 0.08 h	1.72 ± 0.02 g	1.58 ± 0.02 j	13.64 ± 0.01 j	20.90 ± 0.05 j
Konika	4.46 ± 0.06 de	2.27 ± 0.02 e	3.04 ± 0.41 bc	14.14 ± 0.02 i	23.9 ± 0.4 g
Hanacka	4.14 ± 0.02 g	2.14 ± 0.05 f	2.74 ± 0.04 ef	14.21 ± 0.05 i	23.23 ± 0.04 h
Halblange Eagle	4.29 ± 0.02 f	2.56 ± 0.06 cd	3.00 ± 0.02 cd	16.51 ± 0.05 b	26.36 ± 0.01 c
Cukrowa	3.62 ± 0.04 i	3.02 ± 0.01 a	2.51 ± 0.06 gh	15.26 ± 0.04 d	24.4 ± 0.2 f
Alba	4.38 ± 0.01 e	2.70 ± 0.03 b	2.96 ± 0.04 cde	14.36 ± 0.03 h	24.40 ± 0.02 f
Arat	5.47 ± 0.01 a	1.68 ± 0.02 g	1.83 ± 0.06 i	15.36 ± 0.06 d	24.34 ± 0.01 f
Root parsley (Common variety)	5.55 ± 0.01 a	1.65 ± 0.08 g	2.32 ± 0.04 h	15.05 ± 0.07 ef	24.6 ± 0.1 f
Berlinski Halblange Springer	2.93 ± 0.01 k	1.48 ± 0.01 h	1.30 ± 0.01 k	14.78 ± 0.03 g	20.50 ± 0.03 k

Sugar calibration curves: apiose (y = 0.962x, R^2 = 0.998; LLOD = 0.06 mg/mL; LLOQ = 0.21 mg/mL), fructose (y = 1.04x, R^2 = 0.999; LLOD = 0.05 mg/mL; LLOQ = 0.18 mg/mL), glucose (y = 0.935x, R^2 = 0.999; LLOD = 0.08 mg/mL; LLOQ = 0.25 mg/mL) and sucrose (y = 0.977x, R^2 = 0.999; LLOD = 0.06 mg/mL, LLOQ = 0.21 mg/mL). Means followed by different Latin letters in the same column are significantly different according to Tukey's HSD test ($p = 0.05$).

The composition of organic acids in the studied roots is presented in Table 4. The identified compounds included oxalic, malic, citric and succinic acid, while traces of ascorbic and fumaric acid were also detected. A variable composition was recorded among the tested parsley germplasms, with malic acid being the most abundant compound in most of the studied cultivars, namely "Olomuńcka", "Pólna", "Hanacka", "Halblange Eagle", "Alba", "Arat", "Root parsley" and "Berlinski Halblange Springer". Moreover, succinic acid was the richest compound in the cultivars "Linga", "Lenka", "Sonata", "Vistula" and "Konica". Finally, oxalic acid was detected in the highest amounts in the cultivars "Osborne" and "Kaśka," while citric acid was the most profound organic acid in the "Cucrowa" cultivar. Regarding the individual organic acids, the highest content of oxalic acid was recorded in the "Osborne" cultivar; malic acid in the "Root parsley" cultivar; citric acid in the "Linga" cultivar, where the highest total organic acid content was also detected; and succinic acid in the "Sonata" cultivar. In contrast, the lowest amounts of oxalic acid were detected in "Root parsley" and "Berlinski Halblange Springer", and the lowest level of malic acid in "Vistula"; citric acid was the lowest in "Konika", "Alba" and "Berlinski Halblange Springer", while succinic acid was detected in the smallest amounts in "Cucrowa" and "Alba". Finally, the lowest total organic acid content was identified in the "Alba" cultivar. The detected differences indicate a significant genotypic effect on organic acid composition, considering that all the cultivars were grown under the same conditions. Similar compositions of organic acids were reported for parsley shoots and leaves by Saleh et al. [40] and Fernandes et al. [28], although the former also identified isobutyric acid and the latter shikimic acid. Moreover, Gîrd al. [46] suggested that parsley leaves should be considered a source of ascorbic acid, contributing to more than 140% of daily dietary intake. These contradictions are attributable to the different plant parts studied in these reports since, to the best of our knowledge, this is the first report on the organic acid composition of turnip-rooted parsley roots. However, Tkacz et al. [43] reported a similar composition of organic acids in a sea-buckthorn-based beverage that contained the pulp of parsley roots, while Priecina et al. [47] reported the presence of the same compounds, as well as salicylic and butyric acid, in celery roots.

The main fatty acid composition (relative %) of the studied parsley roots is presented in Table 5. Twenty-one individual fatty acids were identified in all the studied samples (Supplementary Table S1). The most abundant compounds were linoleic (47.9–57.1%, in "Olomuńcka" and "Sonata", respectively) and palmitic acid (20.66–20.5% in "Halblange Eagle" and "Root parsley", respectively), followed by oleic (5.57–10.43% in "Halblange Berlinska" and "Pólna", respectively) and linolenic acid (5.12–9.63% in "Lenka" and "Kaśka", respectively). Other fatty acids detected in quantities >1% were palmitic (0.928–1.847%, in "Halblange Eagle" and "Olomuńcka", respectively), behenic (0.669–1.45%, "Konika" and "Olomuńcka", respectively), eicosapentaenoic (0.87–3.98%, in "Berlinski Halblange Springer" and "Halblange Berlinska", respectively) and lignoceric acids (0.813–2.19%, "Konika" and "Olomuńcka", respectively). Moreover, the most abundant class of fatty acids was polyunsaturated fatty acids (PUFA: 56.7–66.5%), followed by saturated fatty acids (SFA: 25.7–35.57%) and monounsaturated fatty acids (MUFA: 6.03–10.9%). Similar results were reported by Makarenko et al. [48], who also identified linoleic and palmitic acids as the major fatty acids in parsley roots and further suggested the effect of temperature on fatty acid composition. The same authors also highlighted the importance of the high PUFA content in vacuole membranes, since they are responsible for membrane plasticity and integrity [48]. Moreover, in the early study by Ellenbracht et al. [49] it was reported that, apart from linoleic and palmitic acids, there were two C18:1 fatty acids identified as (Z)-9 (oleic acid) and (Z)-11 (vaccenic acid) isomers, whereas petroselinic acid, which was detected mostly in seeds and in lesser amounts in leaves, was not detected in parsley roots. Another nutritional aspect related to fatty acid composition is that the ratio of n6/n3 fatty acids was higher than 4.0 for all the studied cultivars (values ranged between 4.45 and 7.49 in "Kaśka" and "Lenka", respectively), which does not meet the recommended criteria for beneficial health effects (the recommended value of this ratio is below 4.0) [50]. On the other hand, the ratio of PUFA/SFA was higher than 0.45 (values ranged between 1.59 and 2.56 in "Olomuńcka" and "Halblange Eagle", respectively) in all the tested cultivars, which is typical of a healthy diet [51].

The details regarding the identification of the detected phenolic compounds are presented in Table 6; nineteen individual phenolic compounds were tentatively identified (a detailed profile of phenolic compounds is provided in Supplementary Table S2). In particular, three phenolic acids were identified as caffeic, *p*-coumaric acid and cinnamic acid derivatives (peaks 1 to 4), while the rest of the compounds were classified as hydrolyzable tannins (peaks 7 and 10) and flavonoids (peaks 4 to 6, 8, 9 and 11 to 19). The composition of the main phenolic compounds detected in parsley roots is presented in Table 7. Variable content levels were recorded among the studied cultivars, and the most abundant compound was apigenin-*O*-pentoside-*O*-hexoside (peak 12), which was detected at 24 mg/g extract in "Berlinski Halblange Springer", followed by apigenin-*O*-acetyl-hexosyl-pentoside (peak 17: detected at 18.3 mg/g of extract in "Vistula") and acetylated luteolin hexoxyl-rhamnoside (peak 18: detected at 7.36 mg/g extract in "Berlinski Halblange Springer"). Flavonoids were the most abundant class of polyphenols, with the highest overall content being recorded for "Konica" and "Berlinski Halblange Springer" (54 mg/g extract and 56 mg/g extract, respectively). The total hydrolyzable tannins and total phenolic acids were less abundant, and the highest content levels were observed in the "Pólna" and "Olomuńcka" cultivars (2.89 mg/g extract and 1.9 mg/g extract, respectively). Finally, "Berlinski Halblange Springer" was the cultivar with the highest total content of phenolic compounds (59 mg/g extract). The prevalence of flavonoids compared to phenolic acids was also reported by Emad et al. [52], who evaluated total phenolic and flavonoid contents in parsley plant parts and also suggested that roots were more abundant in phenolic compounds than shoots. However, this finding was not confirmed by our team; a genotypic effect was recorded, and the phenolic content of the roots was not always higher than leaves in the tested cultivars [27]. Moreover, in the study by Emad et al. [52], a significant impact of the solvent was observed on the recovery of phenolic compounds, with methanol and water being more effective in leaf and root extracts, respectively.

Table 4. Composition of organic acids in the roots of the studied turnip-rooted parsley cultivars (g/100 g dw) (mean ± SD, $n = 3$).

Cultivar	Oxalic Acid	Malic Acid	Ascorbic Acid	Citric Acid	Succinic Acid	Fumaric Acid	Total Organic Acids
Olomuńcka	1.82 ± 0.03 e	2.02 ± 0.01 f	tr	1.70 ± 0.02 fgh	1.85 ± 0.02 g	tr	7.38 ± 0.09 f
Pólna	1.38 ± 0.03 g	2.08 ± 0.04 e	tr	1.66 ± 0.03 ghi	1.70 ± 0.01 h	tr	6.81 ± 0.01 h
Linga	2.06 ± 0.02 c	1.92 ± 0.02 g	tr	2.23 ± 0.03 a	3.08 ± 0.04 b	tr	9.3 ± 0.1 a
Halblange Berlinska	1.77 ± 0.02 f	1.86 ± 0.01 h	tr	1.63 ± 0.02 ijk	1.88 ± 0.04 g	tr	7.14 ± 0.07 g
Osborne	2.67 ± 0.01 a	1.74 ± 0.02 i	tr	2.02 ± 0.02 d	1.91 ± 0.01 g	tr	8.35 ± 0.04 c
Lenka	1.84 ± 0.02 e	1.75 ± 0.02 i	tr	1.71 ± 0.01 fg	2.44 ± 0.02 d	tr	7.73 ± 0.01 e
Sonata	2.00 ± 0.02 d	1.66 ± 0.01 j	tr	2.15 ± 0.04 b	3.27 ± 0.04 a	tr	9.08 ± 0.07 b
Kaśka	2.28 ± 0.01 b	2.04 ± 0.01 ef	tr	1.73 ± 0.03 f	2.08 ± 0.04 f	tr	8.12 ± 0.01 d
Vistula	1.29 ± 0.02 h	1.52 ± 0.01 k	tr	2.00 ± 0.01 d	2.55 ± 0.04 c	tr	7.36 ± 0.01 f
Konika	1.31 ± 0.01 h	1.77 ± 0.01 i	tr	1.58 ± 0.04 kl	1.90 ± 0.05 g	tr	6.55 ± 0.01 ij
Hanacka	1.15 ± 0.01 j	2.25 ± 0.01 c	tr	1.65 ± 0.01 hij	1.60 ± 0.01 i	tr	6.65 ± 0.01 i
Halblange Eagle	1.14 ± 0.01 j	2.17 ± 0.01 d	tr	2.00 ± 0.01 d	1.58 ± 0.04 i	tr	6.89 ± 0.03 h
Cukrowa	1.16 ± 0.01 j	1.89 ± 0.04 gh	tr	2.09 ± 0.01 c	1.33 ± 0.04 j	tr	6.47 ± 0.02 j
Alba	1.20 ± 0.01 i	1.74 ± 0.05 i	tr	1.60 ± 0.01 jkl	1.39 ± 0.05 j	tr	5.94 ± 0.02 k
Arat	1.14 ± 0.01 j	2.41 ± 0.01 b	tr	1.86 ± 0.04 e	2.28 ± 0.03 e	tr	7.68 ± 0.07 e
Root parsley (Common variety)	1.06 ± 0.01 k	2.64 ± 0.01 a	tr	1.72 ± 0.01 f	2.04 ± 0.02 f	tr	7.47 ± 0.03 f
Berlinski Halblange Springer	1.06 ± 0.03 k	2.37 ± 0.06 b	tr	1.56 ± 0.02 l	1.53 ± 0.01 i	tr	6.52 ± 0.06 j

tr—traces; means followed by different Latin letters in the same column are significantly different according to Tukey's HSD test ($p = 0.05$). Organic acid calibration curves: oxalic acid ($y = 9 \times 10^6x + 45{,}9731$; $R^2 = 0.990$; LLOD = 12.6 µg/mL; LLOQ = 41.8 µg/mL); malic acid ($y = 912{,}441x + 92{,}665$; $R^2 = 0.999$; LLOD = 35.8 µg/mL; LLOQ = 119.2 µg/mL); ascorbic acid ($y = 7 \times 10^7x + 60{,}489$; $R^2 = 0.999$; LLOD = 367 µg/mL; LLOQ = 1222 µg/mL); citric acid ($y = 1 \times 10^6x + 45{,}682$; $R^2 = 1$; LLOD = 10.47 µg/mL; LOQ = 34.91 µg/mL), succinic acid ($y = 603{,}298\ x + 4994.1$; $R^2 = 1$; LLOD = 0.019 µg/mL; LLOQ = 0.064 µg/mL) and fumaric acid ($y = 1 \times 10^8x + 614{,}399$; $R^2 = 1$; LLOD = 0.08 µg/mL; LLOQ = 0.26 µg/mL).

Table 5. The main fatty acid composition (%) of the roots of the studied turnip-rooted parsley genotypes (mean ± SD, $n = 3$).

	C16:0	C18:0	C18:1n9c	C18:2n6c	C18:3n3	C22:0	C20:5n3	C24:0	SFA	MUFA	PUFA
Olomuńcka	25.25 ± 0.03 b	1.847 ± 0.002 a	6.9 ± 0.3 f	47.9 ± 0.2 j	5.89 ± 0.07 j	1.45 ± 0.01 a	2.59 ± 0.01 g	2.19 ± 0.01 a	35.57 ± 0.03 a	7.7 ± 0.3 e	56.7 ± 0.2 j
Pólna	21.11 ± 0.02 ij	1.29 ± 0.01 d	10.43 ± 0.02 a	50.86 ± 0.01 i	6.86 ± 0.03 e	1.00 ± 0.01 f	2.23 ± 0.02 j	1.67 ± 0.04 b	28.68 ± 0.03 gh	10.90 ± 0.01 a	60.42 ± 0.02 g
Linga	21.96 ± 0.02 gh	1.23 ± 0.01 e	5.83 ± 0.06 ij	54.57 ± 0.08 de	7.33 ± 0.02 d	1.19 ± 0.01 c	2.55 ± 0.01 g	1.64 ± 0.01 b	28.96 ± 0.01 efgh	6.42 ± 0.07 h	64.62 ± 0.08 d
Halblange Berlinska	21.1 ± 0.8 ij	1.12 ± 0.02 f	5.57 ± 0.07 k	55.6 ± 0.6 c	6.71 ± 0.03 f	0.923 ± 0.024 g	3.98 ± 0.02 a	1.35 ± 0.01 d	27.5 ± 0.8 ij	6.03 ± 0.07 i	66.5 ± 0.7 a
Osborne	22.73 ± 0.01 ef	1.25 ± 0.01 e	6.64 ± 0.06 g	53.43 ± 0.01 gh	6.45 ± 0.06 g	1.20 ± 0.01 c	2.26 ± 0.06 j	1.44 ± 0.02 c	30.50 ± 0.03 d	7.18 ± 0.07 f	62.3 ± 0.1 f
Lenka	22.4 ± 0.5 fg	1.05 ± 0.01 gh	8.6 ± 0.1 b	55.0 ± 0.4 d	5.12 ± 0.01 l	0.862 ± 0.005 h	2.22 ± 0.01 j	1.19 ± 0.01 g	28.4 ± 0.5 h	9.1 ± 0.1 b	62.5 ± 0.4 f
Sonata	21.46 ± 0.04 hi	1.04 ± 0.01 gh	6.81 ± 0.09 fg	57.1 ± 0.2 a	5.54 ± 0.04 k	1.03 ± 0.01 e	2.74 ± 0.01 f	1.43 ± 0.02 c	27.23 ± 0.01 j	7.2 ± 0.1 f	65.6 ± 0.1 bc
Kaśka	21.4 ± 0.1 hi	1.14 ± 0.01 f	6.74 ± 0.01 fg	53.4 ± 0.2 h	9.63 ± 0.01 a	0.849 ± 0.001 hi	2.35 ± 0.01 i	1.25 ± 0.01 f	27.2 ± 0.1 ij	7.21 ± 0.02 f	65.5 ± 0.2 c
Vistula	23.30 ± 0.01 d	0.980 ± 0.003 i	7.29 ± 0.01 e	53.91 ± 0.01 fg	6.90 ± 0.01 e	0.86 ± 0.01 h	2.44 ± 0.01 h	1.10 ± 0.01 h	28.75 ± 0.01 fgh	7.86 ± 0.01 e	63.39 ± 0.01 e
Konika	22.4 ± 0.2 fg	1.03 ± 0.01 h	5.7 ± 0.2 jk	56.59 ± 0.3 b	6.17 ± 0.01 i	0.669 ± 0.006 j	3.19 ± 0.01 e	0.813 ± 0.004 k	27.8 ± 0.1 i	6.1 ± 0.2 i	66.1 ± 0.3 ab
Hanacka	22.7 ± 0.1 ef	1.15 ± 0.01 f	6.31 ± 0.01 h	55.0 ± 0.2 d	6.25 ± 0.01 h	0.830 ± 0.003 i	3.26 ± 0.01 d	0.929 ± 0.001 j	28.6 ± 0.2 h	6.7 ± 0.1 g	64.7 ± 0.1 d
Halblange Eagle	20.66 ± 0.02 j	0.928 ± 0.004 j	8.22 ± 0.03 c	56.55 ± 0.01 b	5.61 ± 0.01 k	0.690 ± 0.008 j	3.33 ± 0.01 c	0.931 ± 0.008 j	25.70 ± 0.01 k	8.65 ± 0.02 c	65.66 ± 0.01 bc
Cukrowa	23.10 ± 0.08 de	1.24 ± 0.01 e	6.74 ± 0.04 fg	54.1 ± 0.2 ef	8.15 ± 0.05 b	0.929 ± 0.008 g	1.32 ± 0.01 k	1.25 ± 0.01 f	29.16 ± 0.07 efg	7.17 ± 0.05	63.7 ± 0.1 e
Alba	22.2 ± 0.1 fg	1.55 ± 0.04 b	6.35 ± 0.04 h	53.3 ± 0.1 h	6.40 ± 0.01 g	1.06 ± 0.01 d	3.82 ± 0.07 b	1.31 ± 0.01 de	29.47 ± 0.06 e	6.80 ± 0.03 g	63.72 ± 0.03 e
Arat	25.60 ± 0.09 b	1.49 ± 0.01 c	5.93 ± 0.01 i	50.8 ± 0.1 i	6.91 ± 0.01 e	1.25 ± 0.01 b	1.15 ± 0.01 m	1.30 ± 0.01 e	34.42 ± 0.08 b	6.50 ± 0.02 h	59.1 ± 0.1 h
Root parsley (Common variety)	26.5 ± 0.3 a	1.55 ± 0.01 b	7.61 ± 0.04 d	50.6 ± 0.4 i	6.26 ± 0.05 h	1.05 ± 0.03 de	1.25 ± 0.01 l	1.06 ± 0.03 i	33.6 ± 0.4 c	8.14 ± 0.06 d	58.3 ± 0.3 i
Berlinski Halblange Springer	24.1 ± 0.2 c	1.07 ± 0.04 g	7.41 ± 0.01 e	54.1 ± 0.3 ef	7.78 ± 0.06 c	0.797 ± 0.009 j	0.87 ± 0.03 n	0.93 ± 0.01 j	29.3 ± 0.3 ef	7.86 ± 0.01 e	62.8 ± 0.3 f

C16:0—palmitic acid; C18:0—stearic acid; C18:1n9c—oleic acid; C18:2n6c—linoleic acid; C18:3n3—linolenic acid; C22:0—behenic acid; C20:5n3—eicosapentaenoic acid; C24:0—lignoceric acid; SFA—saturated fatty acids; MUFA—monounsaturated fatty acids; PUFA—polyunsaturated fatty acids. Means followed by different Latin letters in the same column are significantly different according to Tukey's HSD test ($p = 0.05$).

Table 6. Retention time (Rt), wavelengths of maximum absorption in the visible region (λ_{max}), and mass spectral data of the identified phenolic compounds in the hydroethanolic extracts of roots of the studied turnip-rooted parsley cultivars.

Peak	Rt (min)	λ_{max} (nm)	$[M-H]^-$ (*m*/*z*)	MS^2 (*m*/*z*)	Tentative Identification of Compounds
1	3.71	317	387	193 (100), 179 (3), 161 (8), 133 (4)	Dimer of caffeic acid methyl ester
2	4.01	321	455	325 (44), 265 (95), 235 (100), 163 (37)	*p*-coumaric acid derivative
3	4.29	328	455	325 (44), 265 (95), 235 (100), 163 (37)	*p*-coumaric acid derivative
4	6.4	324	383	127 (100)	Dimethoxycinnamoyl glucoronide
5	8.65	316	895	563 (26), 447 (16), 357 (76), 339 (10), 327 (6), 285 (93)	Luteolin 7-*O*-[6″-dihydrogalloyl]-glucosyl-8-*C*-pentosyl-(1→6)-glucoside
6	9.95	329	901	755 (100), 609 (2), 285 (10)	Kaempferol-3-*O*-[6-*p*-coumaroyl-(2-hexosyl)]hexoside-7-*O*-rhamnoside
7	10.96	275	933	915 (12), 765 (10),631 (3), 613 (3), 463 (10), 301 (42)	Castalagin/vescalagin
8	12.78	321	577	755 (100), 609 (2), 285 (10)	Kaempferol-7-*O*-[2-*p*-coumaroyl-(-2-hexosyl)]hexoside-3-*O*-rhamnoside
9	14.87	332	915	871 (100), 829 (31), 665 (28), 665 (24), 285 (18)	6,8-di-*C*-(6″-malonylsinapoyl)glucosyl chrysoeriol
10	15.45	276	935	917 (50), 783 (40), 633 (132)	Galloyl-bis-HHDP-glucose
11	16.83	338	607	579 (100), 493 (98), 269 (100)	Apigenin-*O*-glucuronylhexoside
12	20.75	338	563	431 (21), 269 (100)	Apigenin-*O*-pentoside-*O*-hexoside
13	22.07	342	609	447 (57), 285 (100)	Kaempferol-3,7-di-*O*-glucoside
14	23.13	342	649	607 (6), 431 (42), 285 (31)	Kaempferol-(acyl)glucuronide-*O*-rhamnoside isomer I
15	23.44	341	649	607 (6), 431 (42), 285 (31)	Kaempferol-(acyl)glucuronide-*O*-rhamnoside isomer II
16	24.63	338	605	563 (100), 269 (49)	Acetylated apigenin-*C*-hexoside-*O*-pentoside
17	25.78	338	605	563 (100), 269 (41)	Apigenin-*O*-acetyl-hexosyl-pentoside
18	26.72	342	635	299 (100), 284 (36)	Acetylated luteolin hexoxyl-rhamnoside
19	27.48	344	635	593 (57), 285 (100)	Kaempferol-(*p*-coumaroyl)-hexoside

Table 7. The content of the main phenolic compounds (mg/g of extract) identified in the hydroethanolic extracts of roots of the studied turnip-rooted parsley cultivars (mean ± SD, $n = 3$).

Cultivar	5	7	10	12	13	15	16	17	18	19	TPA	TF	THT	TPC
Olomuńcka	3.7 ± 0.1 a	1.64 ± 0.03 a	tr	tr	1.21 ± 0.01 f	0.568 ± 0.002 h	0.13 ± 0.01 l	3.7 ± 0.1 jk	1.55 ± 0.03 k	0.558 ± 0.003 m	1.9 ± 0.1 a	13.6 ± 0.1 i	1.64 ± 0.03 j	17.11 ± 0.2 j
Pólna	0.492 ± 0.001 cdef	1.484 ± 0.002 b	1.404 ± 0.003 a	8.48 ± 0.01 h	0.91 ± 0.02 h	0.8 ± 0.02 f	1.07 ± 0.02 i	6.03 ± 0.03 h	2.12 ± 0.02 i	0.86 ± 0.01 j	0.4 ± 0.01 b	23.4 ± 0.1 g	2.89 ± 0.01 a	26.7 ± 0.2 h
Linga	0.4876 ± 0.0004 def	1.322 ± 0.001 ef	1.276 ± 0.003 ef	6.11 ± 0.05 i	0.86 ± 0.04 i	1 ± 0.01 d	1.6 ± 0.1 g	9 ± 0.1 fg	3.33 ± 0.01 g	1.02 ± 0.02 h	0.32 ± 0.01 cd	25 ± 0.1 fg	2.598 ± 0.003 e	27.9 ± 0.1 gh
Halblange Berlinska	0.471 ± 0.001 efg	1.274 ± 0.003 i	1.246 ± 0.003 i	4.44 ± 0.02 j	0.676 ± 0.004 k	0.678 ± 0.004 g	0.81 ± 0.02 j	5.2 ± 0.1 hi	2 ± 0.1 i	0.708 ± 0.002 l	0.145 ± 0.003 f	17 ± 0.2 h	2.52 ± 0.01 gh	19.7 ± 0.2 i
Osborne	0.451 ± 0.001 g	1.268 ± 0.003 i	1.264 ± 0.003 gh	1.36 ± 0.01 k	0.503 ± 0.002 l	0.505 ± 0.001 i	0.11 ± 0.01 l	1.22 ± 0.05 l	0.663 ± 0.001 m	0.539 ± 0.002 m	0.08 ± 0 g	7.32 ± 0.03 j	2.53 ± 0.01 g	9.93 ± 0.02 k
Lenka	0.483 ± 0.001 defg	1.293 ± 0.003 gh	1.295 ± 0.003 c	15.61 ± 0.4 e	1.24 ± 0.01 f	1.12 ± 0.02 c	2.4 ± 0.1 e	12.4 ± 0.7 d	4.6 ± 0.1 e	1.24 ± 0.01 de	0.311 ± 0.002 cd	41 ± 1 c	2.59 ± 0.01 e	44 ± 1 d
Sonata	0.57 ± 0.004 b	1.31 ± 0.01 fg	1.325 ± 0.003 b	12.83 ± 0.4 g	1.21 ± 0.01 f	0.89 ± 0.02 e	1.46 ± 0.05 h	8.1 ± 0.1 g	3.1 ± 0.1 h	0.98 ± 0.02 i	0.33 ± 0.01 cd	31 ± 0.5 e	2.63 ± 0.01 c	34 ± 0.5 f
Kaśka	0.477 ± 0.001 defg	1.354 ± 0.003 d	1.27 ± 0.01 g	6.1 ± 0.1 i	0.8 ± 0.02 j	0.82 ± 0.05 f	1.49 ± 0.05 h	9.36 ± 0.05 ef	3.4 ± 0.1 fg	1.21 ± 0.02 ef	0.29 ± 0.01 d	25.97 ± 0.3 f	2.62 ± 0.01 cd	28.9 ± 0.3 g
Vistula	0.463 ± 0.001 fg	1.291 ± 0.003 gh	1.269 ± 0.002 fg	4.8 ± 0.1 j	0.654 ± 0.003 k	0.65 ± 0.001 g	0.54 ± 0.01 k	3.14 ± 0.05 k	1.17 ± 0.01 l	0.679 ± 0.004 l	0.21 ± 0.01 e	13.7 ± 0.1 i	2.56 ± 0.005 f	16.5 ± 0.2 j
Konika	0.511 ± 0.002 cd	1.27 ± 0.01 i	tr	18.8 ± 0.5 c	1.62 ± 0.02 c	1.28 ± 0.02 a	3.8 ± 0.1 a	18.3 ± 0.5 a	6.7 ± 0.1 b	1.47 ± 0.02 c	0.32 ± 0.01 cd	54 ± 1 a	1.27 ± 0.01 k	56 ± 1 b
Hanacka	0.499 ± 0.001 cde	1.385 ± 0.003 c	1.286 ± 0.003 d	5.9 ± 0.1 i	0.8 ± 0.01 j	0.678 ± 0.002 g	0.77 ± 0.01 j	4.57 ± 0.2 ij	1.86 ± 0.05 j	0.81 ± 0.04 k	0.32 ± 0.01 cd	18.2 ± 0.4 h	2.67 ± 0.01 b	21.2 ± 0.4 i
Halblange Eagle	0.473 ± 0.001 efg	1.27 ± 0.01 i	1.24 ± 0.01 ij	15 ± 1 ef	1.22 ± 0.02 f	1.04 ± 0.01 d	2.1 ± 0.1 f	9.6 ± 0.1 ef	3.53 ± 0.05 f	1.18 ± 0.02 fg	0.3 ± 0.01 cd	36 ± 1 d	2.51 ± 0.01 h	38 ± 1 e
Cukrowa	0.477 ± 0.001 defg	1.28 ± 0.01 hi	1.259 ± 0.003 h	9.1 ± 0.1 h	1 ± 0.02 g	0.91 ± 0.04 e	2.07 ± 0.05 f	14 ± 1 c	5.2 ± 0.1 d	1.27 ± 0.02 d	0.323 ± 0.002 cd	35.6 ± 1 d	2.54 ± 0.01 g	38 ± 1 e
Alba	0.495 ± 0.001 cdef	1.321 ± 0.002 ef	1.277 ± 0.003 e	17.6 ± 0.5 d	1.52 ± 0.02 d	1.14 ± 0.02 c	2.56 ± 0.05 d	13 ± 1 d	4.57 ± 0.04 e	1.14 ± 0.02 g	0.219 ± 0.003 e	43 ± 1 c	2.6 ± 0.01 e	46 ± 1 d
Arat	0.53 ± 0.01 c	1.327 ± 0.003 e	1.275 ± 0.004 ef	22 ± 1 b	2.01 ± 0.03 b	1.11 ± 0.02 c	2.5 ± 0.1 de	10 ± 1 e	4.49 ± 0.05 e	1.15 ± 0.03 g	0.32 ± 0.01 cd	46 ± 1 b	2.6 ± 0.01 de	49 ± 1 c
Root parsley (Common variety)	0.462 ± 0.001 fg	1.267 ± 0.003 i	1.297 ± 0.004 c	14.5 ± 0.5 f	1.29 ± 0.03 e	1.11 ± 0.02 c	2.8 ± 0.1 c	17 ± 1 b	6.53 ± 0.05 c	1.91 ± 0.03 a	0.34 ± 0.01 c	48 ± 2 b	2.56 ± 0.01 f	51 ± 2 c
Berlinski Halblange Springer	0.47 ± 0.01 efg	1.236 ± 0.004 j	1.234 ± 0.003 j	24 ± 1 a	2.16 ± 0.02 a	1.23 ± 0.02 b	3.48 ± 0.1 b	15 ± 1 c	7.36 ± 0.04 a	1.53 ± 0.02 b	0.327 ± 0.004 cd	56 ± 2 a	2.47 ± 0.01 i	59 ± 2 a

tr: traces. TPA: total phenolic acids; TF: total flavonoids; THT: total hydrolyzable tannins; TPC: total phenolic compounds. The peak identification is provided in Table 6. Calibration curves used in the quantification: standard calibration curves: caffeic acid (y = 388,345x + 406,369; $R^2 = 0.999$; LLOD = 0.78 µg/mL and LOQ = 1.97 µg/mL, peak 1); *p*-coumaric acid (y = 301,950x + 6966.7; $R^2 = 0.9999$; LLOD = 0.68 µg/mL and LLOQ = 1.61 µg/mL, peaks 2 and 3); cinnamic acid (y = 1 × 10^6x − 222,204; $R^2 = 0.9993$; LLOD = 0.835 µg/mL and LLOQ = 2.51 µg/mL, peak 4); apigenin-7-*O*-glucoside (y = 10,683x − 45,794; $R^2 = 0.996$; LLOD = 136.95 µg/mL and LLOQ = 414.98 µg/mL, peaks 5, 11, 12, 17 and 18); quercetin-3-*O*-glucoside (y = 34,843x − 160,173; $R^2 = 0.9998$; LLOD = 0.21 µg/mL and LLOQ = 0.71 µg/mL, peaks 6, 8, 13–15 and 19); ellagic acid (y = 26,719x − 317,255; $R^2 = 0.9986$; LLOD = 41.20 µg/mL and LLOQ = 124.84 µg/mL, peaks 7 and 10); naringenin (y = 18,433x + 78,903; $R^2 = 0.9998$; LLOD = 18.66 µg/mL and LLOQ = 56.55 µg/mL, peak 9); apigenin-6-*C*-glucoside (y = 107,025x + 61,531; $R^2 = 0.9989$; LLOD = 0.19 µg/mL and LLOQ = 0.63 µg/mL, peak 16). Means followed by different Latin letters in the same column are significantly different according to Tukey's HSD test ($p = 0.05$).

In the recent study by Arsenov [53], the phenolic compound profile of parsley roots was evaluated, and it was suggested that apiin was the most abundant polyphenol, followed by chlorogenic acid, scopoletin and ferulic acid. These differences in phenolic compound composition could be attributed to different protocols implemented since, according to Emad et al. [52], the extraction method may affect the recovery efficiency of polyphenols. Phenolic acids, such as gallic and ferulic acid, have been previously reported in parsley leaves [54], while Mazzucotelli et al. [55] also identified gallic and hydroxybenzoic acids, Grúz et al. [56] identified dicoumaric acid, Slighoua et al. [57] identified gallic, ferulic and cinnamic acid and Derouich et al. [58] identified caffeic, chlorogenic, *p*-coumaric, ferulic, gallic, syringic and vannilic acid. Moreover, in the study by Tkacz et al. [43], it was suggested that the addition of pulp from parsley roots significantly increased by almost seven times the total phenolic acid content in sea-buckthorn-based smoothies, while the increase was less profound for procyanidin polymers (approximately 1.5 times). However, there are several other studies where the presence of flavonoids was reported (e.g., apigenin and kaempferol derivatives [27]; quercetin, apigenin, luteolin, isorhamnetin, kaempferol and chrysoeriol derivatives [59,60]; apigenin, apiin and cosmosiin [61]; isorhamnetin, apigenin, diosmetin and hesperetin [62]; *p*-coumaroyl hexoside, apigenin, luteolin, isorhamnetin, apigenin and diosmetin [11] and other flavonoids [63]).

The antioxidant activity levels of the root extracts obtained from the studied parsley germplasms are presented in Figures 1 and 2. The results obtained from the TBARS (Figure 1) and OxHLIA (Figure 2) assays differed, and the most effective (i.e., lower EC_{50} values) cultivars for the TBARS assay ("Root parsley" and "Berlinski Halblange Springer") were those with the lowest antioxidant activity for the OxHLIA assay after 120 min. In contrast, the "Vistula" cultivar, which was among the cultivars with the lowest effectiveness as determined by the TBARS assay, was the best-performing cultivar in the OXHLIA assay, recording the lowest overall IC_{50} values at both 60 and 120 min. Comparing these results with those presented in Table 7, it seems that there is no correlation between the phenolic compound content and the antioxidant activity in parsley roots. This finding is similar to previous reports regarding the antioxidant activity of parsley leaves [27], roots [52] and seeds [64], whereas Epifanio et al. [59] attributed the antioxidant activity observed in parsley seeds to apiin and apigenin. Moreover, El-Zaeddi et al. [11], who evaluated the phenolic compound composition and the antioxidant activity in three Apiaceae species (coriander, dill and parsley), suggested a variable association between phenolic compound content and antioxidant activity, depending on the species and the tested assay. In contrast to these reports, several other studies identified phenolic compounds as significant contributors to the overall antioxidant activity of parsley plant parts [14,54,58,65], highlighting the important effect of the implemented assay, the extraction protocol, the plant part used for the extraction and the growing conditions.

The antimicrobial properties of the tested parsley root extracts are presented in Tables 8 and 9. The results for the tests of antimicrobial activity of the studied extracts against several bacteria showed variable effects depending on the cultivar and the bacteria tested (Table 8). In most cases, the root extracts were more efficient or similarly effective compared to the positive controls, and the MBC values of E211 against *Bacilus cereus* and those of E224 against *Staphylococcus aureus* and *Salmonella typhimurium* were the most effective ones. Moreover, the root extracts of the "Olomuńcka" cultivar were effective against all the tested bacteria. Similarly, both the MIC and MBC values of E224 were the lowest against *Trichoderma viride*. On the other hand, all the tested root extracts were more effective than positive controls against all the studied fungi (Table 9), while the extracts of the "Root parsley" cultivar were among the most effective against almost all the tested fungi (except for *Aspergilus niger*). Variable responses against the same microbial agents were also observed for the leaf extracts of the same cultivars tested in the current study [27], while Abdu and Hauwa [66] suggested a significant antibacterial activity for parsley leaf extracts that varied depending on the extraction protocol. Moreover, Farah et al. [67] and Bodeta et al. [68] highlighted the efficiency of parsley ethanolic extracts against *Candida tropical*,

Salmonella typhi and *Staphylococcus aureus*, while hot water extracts of parsley leaves were effective against *S. aureus*, *Pseudomonas aeruginosa* and *Streptococcus pyogenes* [7]. Other plant parts, such as seeds and fruit, exhibited strong antibacterial properties [40,69]; moreover, apart from solvent extracts, essential oils of parsley have shown significant antimicrobial properties, indicating the presence of potent bioactive compounds produced mostly via the shikimate pathway [70–73]. According to Marín et al. [68], the antimicrobial properties of natural matrices are usually associated with the presence of dietary polyphenols that are metabolized by gut microbiota into simple bioactive compounds with diverse effects. The studies of Wolny-Koładka et al. [74] and Roy et al. [75] also suggested using the waste from parsley leaves or stems to produce silver nanoparticles with significant antimicrobial effects against *Klebsiella pneumonia*, *S. aureus* and *Escherichia coli*.

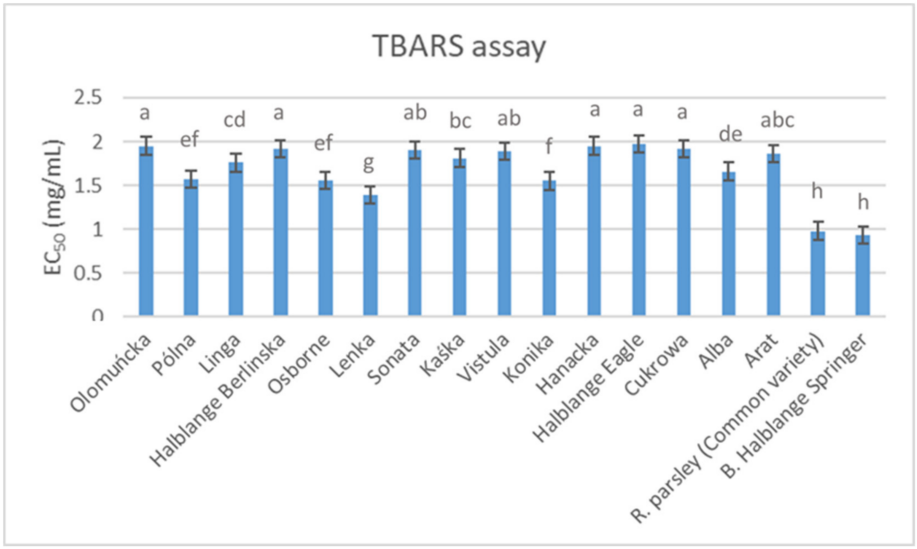

Figure 1. The content of the TBARS assay of the hydroethanolic extracts of roots of the studied turnip-rooted parsley cultivars. Mean values (n = 3); identical superscripts (a–h) denote significantly different values according to Tukey's HSD test (p = 0.05).

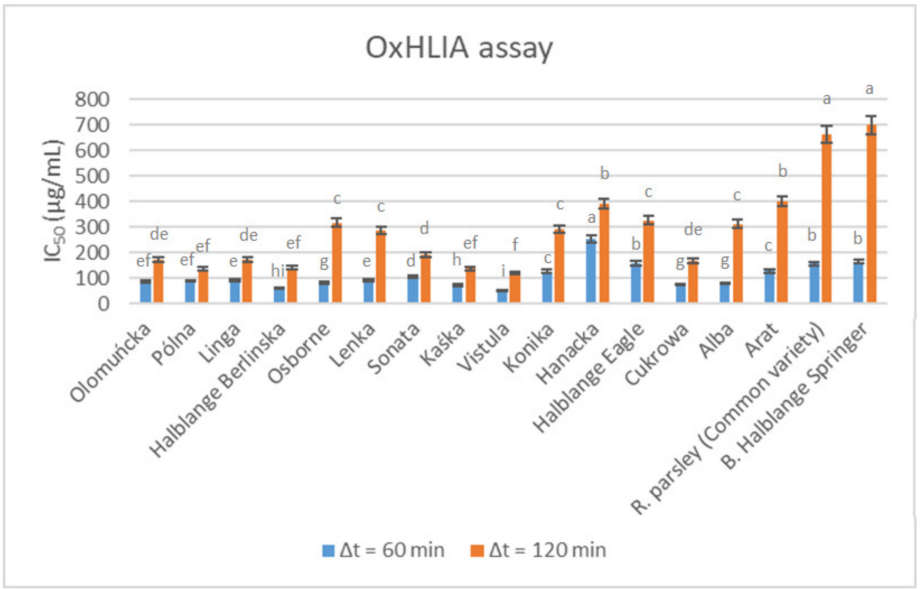

Figure 2. The content of the OxHLIA assay of the hydroethanolic extracts of roots of the studied turnip-rooted parsley cultivars. Mean values (n = 3); identical superscripts (a–i) denote significantly different values according to Tukey's HSD test (p = 0.05).

Table 8. Antibacterial activity (minimal inhibition concentration (MIC) and minimal bactericidal concentration (MBC) mg/mL) of the hydroethanolic extracts of roots the studied turnip-rooted parsley cultivars.

		S. aureus	*B. cereus*	*L. monocytogenes*	*E. coli*	*S. typhimurium*	*E. cloacae*
Olomuńcka	MIC	1	0.5	1	0.5	1	1
	MBC	2	1	2	1	2	2
Pólna	MIC	2	1	2	1	2	2
	MBC	4	2	4	2	4	4
Linga	MIC	2	1	1	1	1	1
	MBC	4	2	2	2	2	2
Halblange Berlinska	MIC	2	1	2	1	2	2
	MBC	4	2	4	2	4	4
Osborne	MIC	1	1	1	1	1	1
	MBC	2	2	2	2	2	2
Lenka	MIC	2	1	2	1	2	2
	MBC	4	2	4	2	4	4
Sonata	MIC	1	1	2	1	2	2
	MBC	2	2	4	2	4	4
Kaśka	MIC	2	2	2	2	2	2
	MBC	4	4	4	4	4	4
Vistula	MIC	2	1	2	1	2	2
	MBC	4	2	4	2	4	4
Konika	MIC	2	1	2	1	2	4
	MBC	4	2	4	2	4	8
Hanacka	MIC	2	1	2	1	2	2
	MBC	4	2	4	2	4	4
Halblange Eagle	MIC	2	2	2	0.5	2	2
	MBC	4	4	4	1	4	4
Cukrowa	MIC	2	2	2	0.5	2	2
	MBC	4	4	4	1	4	4
Alba	MIC	4	1	2	1	2	4
	MBC	8	2	4	2	4	8
Arat	MIC	1	1	2	1	2	2
	MBC	2	2	4	2	4	4
Root parsley (Common variety)	MIC	1	1	1	1	1	1
	MBC	2	2	2	2	2	2
Berlinski Halblange Springer	MIC	1	1	1	1	1	2
	MBC	2	2	2	2	2	4
E211 *	MIC	4.0	0.5	1.0	1.0	1.0	2.0
	MBC	4.0	0.5	2.0	2.0	2.0	4.0
E224 *	MIC	1.0	2.0	0.5	0.5	1.0	0.5
	MBC	1.0	4.0	1.0	1.0	1.0	0.5

* Positive controls.

Table 9. Antifungal activity (MIC and minimal fungicidal concentration (MFC) mg/mL) of the hydroethanolic extracts of roots the studied turnip-rooted parsley cultivars.

		A. fumigatus	*A. niger*	*A. versicolor*	*P. funiculosum*	*P. v.* **var.** *cyclopium*	*T. viride*
Olomuńcka	MIC	0.5	1	0.5	0.5	0.5	0.5
	MFC	1	2	1	1	1	1
Pólna	MIC	0.5	0.12	0.5	0.5	0.25	1
	MFC	1	0.25	1	1	0.5	2
Linga	MIC	0.5	0.5	0.5	0.5	0.5	1
	MFC	1	1	1	1	1	2
Halblange Berlinska	MIC	0.5	0.5	0.5	0.5	0.5	0.5
	MFC	1	1	1	1	1	1
Osborne	MIC	0.5	1	0.5	0.25	0.5	0.5
	MFC	1	2	1	0.5	1	1
Lenka	MIC	0.25	0.5	0.25	0.5	0.5	1
	MFC	0.5	1	0.5	1	1	2
Sonata	MIC	0.5	0.5	0.5	0.5	0.5	0.5
	MFC	1	1	1	1	1	1
Kaśka	MIC	0.5	0.5	0.5	0.5	0.5	1
	MFC	1	1	1	1	1	2
Vistula	MIC	0.5	0.5	0.5	0.5	0.5	0.5
	MFC	1	1	1	1	1	1
Konika	MIC	0.5	0.5	0.5	0.5	0.5	0.5
	MFC	1	1	1	1	1	1
Hanacka	MIC	0.5	0.5	0.5	0.25	0.5	0.5
	MFC	1	1	1	0.5	1	1
Halblange Eagle	MIC	0.25	0.5	0.25	0.25	0.5	0.5
	MFC	0.5	1	0.5	0.5	1	1
Cukrowa	MIC	1	0.5	0.5	0.5	0.25	0.5
	MFC	2	1	1	1	0.5	1
Alba	MIC	0.25	0.5	0.25	0.25	0.5	1
	MFC	0.5	1	0.5	0.5	1	2
Arat	MIC	0.5	0.5	0.5	0.25	0.5	0.5
	MFC	1	1	1	0.5	1	1
Root parsley (Common variety)	MIC	0.25	0.25	0.25	0.25	0.25	0.5
	MFC	0.5	0.5	0.5	0.5	0.5	1
Berlinski Halblange Springer	MIC	0.5	0.5	0.5	0.5	0.5	1
	MFC	1	1	1	1	1	2
E211 *	MIC	1.0	1.0	2.0	1.0	2.0	1.0
	MFC	2.0	2.0	2.0	2.0	4.0	2.0
E224 *	MIC	1.0	1.0	1.0	0.5	1.0	0.5
	MFC	1.0	1.0	1.0	0.5	1.0	0.5

* Positive controls.

4. Conclusions

Our results showed great variability in terms of the chemical composition and bioactive properties of root parsley germplasm, highlighting the high dietary value and the bioactive potential of this underexploited root vegetable species. Previous studies by our team indicated the high nutritional value of the leaves of the same species, which makes it possible to cultivate them as a dual-purpose plant (leaves and roots). Considering that most of the literature reports refer to the nutritional value of plain- or curly-leaf parsley

cultivars, these results are important for the chemical profile characterization and the bioactivity analysis of the roots of turnip-rooted parsley germplasm. Moreover, this genetic material could be further exploited in sustainable and diversified agro-ecosystems through its introduction as a novel/complementary crop in the traditional farming systems of the Mediterranean basin.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/horticulturae8070639/s1, Table S1: fatty acid composition (%) of the studied roots of turnip-rooted parsley genotypes (mean ± SD, n = 3); Table S2: content (mg/g of extract) of the phenolic compounds identified in the hydroethanolic extracts of the studied roots of turnip-rooted parsley genotypes (mean ± SD, n = 3).

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