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Smooth Golden Fleece and Prickly Golden Fleece as Potential New Vegetables for the Ready-To-Eat Production Chain

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Abstract: Smooth golden fleece (*Urospermum dalechampii* (L.) F.W. Schmidt) and prickly golden fleece (*Urospermum picroides* (L.) Scop. ex F.W. Schmid) are two wild edible plants used in traditional cuisine and folk medicine. In this research, the domestication of both species was tested for the first time using a floating system and two plant densities (412 and 824 plants m^{-2}) to evaluate yield and quality. Some quality traits were also compared in cultivated plants and wild ones gathered in grasslands. The results show that both species are suitable for cultivation, although prickly golden fleece showed highest total phenols (132 mg 100 g^{-1} fresh weight—f.w.) and total antioxidant activity (0.19 mg 100 g^{-1} f.w.). At low sowing density, smooth golden fleece showed a nitrate content of about 7200 mg kg^{-1} f.w., 38% higher than plants of the same species grown at high density and plants of prickly golden fleece. These results suggest that high density can be used to optimize yield in two harvests. By permitting modulation of nutrients and a product without soil residues, the floating system used in this study proved suitable for growing *U. dalechhampii* and *U. picroides* as new vegetables for the ready-to-eat production chain.

Keywords: floating system; antioxidants; nutraceuticals; polyphenols; *Urospermum dalechampii* (L.) F.W. Schmidt; *Urospermum picroides* (L.) Scop. ex F.W. Schmidt; wild plants

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1. Introduction

In the past, wild edible plants (WEP) were collected as the only option for survival during wars, famines and chronic poverty [1–4]. Not by chance, WEP are also known as "alimurgic plants", since they can be used for food in case of need. During the first world war, Mattirolo et al. [5] rendered the term more precise, adding the prefix "phyto" to better define the field of interest. Today, WEP can be considered a great historical and cultural heritage that can improve diets [6] and restore a link with old gastronomic traditions [7] and agro-biodiversity [8]. WEP are a favorite delicacy in many countries and represent an extraordinary source of essential elements for the human health. They may be used to diversify and enrich modern diet with many colors and flavors, playing an important role in the diet of inhabitants in different parts of the world [9].

The use of many WEP species has been documented in Italy [10,11], Spain [12], Turkey [13] and Croatia [14]. Wild edible plants can sometimes be found in local markets, especially in Southern Italy, where collectors and sellers are called "terrazzani" [8]. Although several wild species were used as food in the past, today they are almost unknown to most, only continuing to be recognized by old and rural people [8].

World population is estimated to reach 9 billion by the year 2050. Since more than 16% of the population is already malnourished, expected population growth is a real challenge for food security [15]. Neglected and underutilized species could therefore contribute to food security and ensure nutrients to people at local and regional levels [16].

Many studies report that WEP are high in nutrients such as carotenoids, vitamins, minerals and other antioxidant compounds [9,17], and in polyphenols with antioxidant and antimicrobial properties [18–21]. Some WEP may therefore be considered "nutraceuticals" [6].

Attempts have been made to cultivate certain WEP in the open field, greenhouses and even in soilless systems. For example, *Asparagus acutifolius* L. [22], *Diplotaxis tenuifolia* L. [23], *Borago officinalis* L. and *Taraxacum officinalis* L. [24], *Muscari comosum* (L.) Mill. [25], *Brassica fruticulosa* Cyr. [26], *Crithmum maritimum* L. [27] and *Portulaca oleracea* L. [28,29] could be cultivated on a large scale. Others could be exploited on a large-scale as new crops expressing agro-biodiversity [9]. In this context, it is interesting to note that many WEP are listed as an item in the 'List of Traditional Agri-Food Products' (TAFP) of the Italian Department for Agriculture, since their processing, preservation and ageing methods are consolidated in time, harmonious for all the region involved, according to traditional rules, for a period not less than 25 years [8].

Smooth golden fleece (*Urospermum dalechampii* [L.] F.W. Schmidt) and prickly golden fleece (*Urospermum picroides* [L.] Scop. ex F.W. Schmid) are the only known species of the genus *Urospermum* (Asteraceae) [30]. In many areas of the Mediterranean, both are used in folk medicine and in traditional recipes in place of other cultivated vegetables [31]. For example, leaves, floral buds and roots of *U. dalechampii* can be used in the same way as spinach, capers and potatoes, respectively, while for medical purposes, infusions of certain plant parts are suggested for their diuretic, digestive, and tonic properties [32]. Likewise, prickly golden fleece can be used in traditional cuisine, raw in salads, boiled and seasoned with extra virgin olive oil, or cooked in soups [4]. Some authors [33] have reported promising anti-inflammatory properties of extracts of *U. picroides*. Importantly, both species are in the TAFP list under "foglie miste" (Italian for mix of leafy vegetables), a mix of WEP used in traditional recipes in Puglia (Southern Italy) [31].

To the best of our knowledge, the literature lacks information on the domestication and technical aspects of growing techniques for *U. dalechampii* and *U. picroides*. More information is therefore needed to exploit these WEP as new crops in a large-scale context.

The aim of the present study was to investigate the cultivation of smooth golden fleece and prickly golden fleece as new vegetables for the ready-to-eat production chain. We focused on: (i) evaluation of yield and quality of the two species grown in a floating system at two plant densities; and (ii) comparison of quality traits of cultivated and wild specimens gathered in grasslands.

2. Materials and Methods

2.1. Plant Material and Experimental Conditions

The experiment was carried out in a greenhouse of the Experimental Farm "La Noria" of the Institute of Sciences of Food Production, National Research Council, Mola di Bari, Southern Italy (41°03′ N, 17°04′ E, altitude 24 m).

Seeds of *U. delechampii* and *U. picroides* were harvested in June and July from uncultivated fields in the countryside of Valenzano, Bari, Italy. On 7 October, seeds were sown in cells containing a peat-based commercial substrate (Brill Type 3 Special, mix of different peats supplemented with 1 kg m^{-3} PIG-MIX 14N-16P-18K fertilizer). When seedlings reached the three true-leaf stage, the cell pots were placed in benches (galvanized sheet iron, 2000 × 800 × 100 mm^3) and grown in a floating hydroponic system using a nutrient solution composed of 140, 300, 60, 40, 150, 130 mg/L NO_3^-, K^+, $H_2PO_4^-$, Mg^{2+}, Ca^{2+}, SO_4^{2-}, respectively. Micronutrients were added as defined in the nutrient solution proposed by Johnson et al. [34].

Two different sowing densities were used: 140 and 70 plants per tray, leading to 824 and 412 plants m^{-2} (D1 and D2, respectively). A completely randomized design with three replications was used. Each replication consisted of 30 plants.

Nutrient solution pH was measured (portable pH meter, HI 9025; Hanna Instruments, Padova, Italy) daily and adjusted to 5.5–6.0 using 1 M H_2SO_4. Dissolved oxygen was measured (Dissolved Oxygen Meter, Hanna Instruments, HI 9142) daily; an air pump was

used to promote oxygenation of the nutrient solution so as to avoid root anoxia issues. During the experiment, the average temperature in the greenhouse was 16.3 °C, minimum 4 °C, maximum 38 °C. Average relative humidity was 59.0%, min. 26.8%, max. 99.6%.

Two harvests were made, cutting the leaves and allowing them to grow again, so as to optimize yield. The first harvests were on 11 and 20 November for *U. picroides* and *U. dalechampii*, respectively; the second on 16 December and 13 January, respectively. On 2 December fresh leaves of smooth golden fleece and prickly golden fleece were also harvested from uncultivated fields near Valenzano (Bari, Italy) and their chemical composition compared with that of the cultivated samples. Fresh leaves were washed, spin dried and placed in envelopes until measurement and analysis.

2.2. Physical Measurements

The Soil Plant Analysis Development (SPAD) index was measured with a chlorophyll meter (SPAD 502 Plus Minolta). Leaf area was measured with a leaf area meter (LI-3100; LI-COR, Lincoln, NE, USA). To measure dry weight of edible parts, fresh samples were maintained in a forced draft oven at 65 °C until a constant weight.

2.3. Inorganic Ions Content

An ion exchange chromatograph (Dionex DX120; Dionex Corporation, Sunnyvale, CA, USA) equipped with conductivity detector was used to determine nitrate, Cl^-, SO_4^{2-} and $H_2PO_4^-$ contents in 0.5 g of dried sample with an IonPac AG14 precolumn and an IonPac AS14 analytical column (Dionex Corporation). For the determination of cation contents (Na^+, K^+, Mg^{2+} and Ca^{2+}), 1 g of dried sample was ashed in a muffle furnace at 550 °C and digested with 20 mL 1 mol L^{-1} HCl in boiling water (99.5 ± 0.5 °C) for 30 min. The resulting solution was filtered, diluted and analysed by ion chromatography (Dionex DX120, Dionex Corporation) with a conductivity detector using an IonPac CG12A guard column and an IonPac CS12A analytical column (Dionex Corporation).

2.4. Total Phenols (TP) and Total Antioxidant Activity (TAA)

For each replicate, 30 g of fresh leaf tissue was homogenized and refluxed in a hot water bath (twice for 1 h) with boiling methanol (1:5 *w/v*). Plant residues were removed by filtration through Whatman Grade 1 filter paper. Methanol extracts were concentrated to dryness under vacuum in a rotary evaporator (P = 20 mbar, T = 30 °C), and then dissolved and brought to a final volume of 100 mL with 50% methanol/water solution. After filtration through Whatman Grade 1 filter paper, the final extract was used for TP content evaluation and TAA assay. All TP and TAA analyses were performed in three replicates.

Total phenol content was evaluated by the Folin–Ciocalteu method as reported by Sergio et al. [21]. Caffeic acid was used as reference standard; phenol concentration was therefore estimated as caffeic acid equivalent (CAE) and expressed in mg CAE 100 g^{-1} f.w.

Total antioxidant activity was assayed by ABTS (2,2′-azino-bis-3-ethylbenzothiazoline-6-sulphonic acid) radical cation assay as reported by Sergio et al. [21]. Antiradical activity was expressed as g Trolox 100 g^{-1} f.w. (Trolox = 6-hydroxy-2,5,7,8-tetramethylchromane-2-carboxylic acid).

2.5. Statistical Analysis

Two-way analysis of variance (ANOVA) was carried out using the general linear model procedure of SAS software (SAS Version 9.1, SAS Institute, Cary, NC, USA). A completely randomized design was applied with species (S) and plant density (D) as main factors. Means were compared using the Student-Newman-Keuls (SNK) test at $p = 0.05$. Significance of main factors and their interaction are reported in tables. Average values of main factors are reported in tables, while average values of significant interactions S × D are showed in histograms.

3. Results and Discussion

3.1. Crop Performance and Physical Traits of Cultivated Plants

In both harvests, the interaction between species and density was not significant for yield or physical traits of cultivated plants (Tables 1 and 2). In the first harvest, average leaf number, leaf weight and leaf area were 3.2 plant^{-1}, 660 mg leaf^{-1} and 71.7 cm^2 plant^{-1}, respectively (Table 1). At density D1 we obtained a yield 57% higher and dry weight 20% lower than at D2; *U. delechampii* showed a higher SPAD index (Table 1). In the second harvest the average yield was 1441 g m^{-2}, without differences in relation to species or density. *U. delechampii* showed leaf number and SPAD that were 90% and 46% higher, respectively, than *U. picroides*, while leaf weight and dry weight were 59% and 15% higher in *U. picroides* than in *U. delechampii*. At density D2, leaf area was 40% higher than at D1 (Table 2).

Table 1. Yield and physical traits of smooth golden fleece (*U. delechampii*) and prickly golden fleece (*U. picroides*) grown in a floating system at two sowing densities (first harvest).

	Leaf Number (n Plant $^{-1}$)	Leaf Weight (mg Leaf $^{-1}$)	Leaf Area (cm^2 Plant^{-1})	Yield (g m^{-2})	SPAD Index	Dry Weight (g 100 g^{-1} f.w.)
Species						
U. delechampii	3.1	723	69.1	1101	29.5	5.9
U. picroides	3.3	597	74.3	1258	26.4	5.6
Density (plants m^{-2})						
824 (D1)	3.1	614	65.5	1441	27.5	5.1
412 (D2)	3.4	705	78.0	919	28.4	6.4
Significance						
Species (S)	ns	ns	ns	ns	***	ns
Density (D)	ns	ns	ns	*	ns	*
S × D	ns	ns	ns	ns	ns	ns

Significance: ns = not significant; * and ***, significant at $p \leq 0.05$ and $p \leq 0.001$, respectively.

Table 2. Yield and physical traits of smooth golden fleece (*U. delechampii*) and prickly golden fleece (*U. picroides*) grown in a floating system at two sowing densities (second harvest).

	Number of Leaves (n Plant $^{-1}$)	Leaf Weight (mg Leaf $^{-1}$)	Leaf Area (cm^2 Plant^{-1})	Yield (g m^{-2})	SPAD Index	Dry Weight (g 100 g^{-1} f.w.)
Species						
U. delechampii	6.1	629	98.0	1464	43.0	7.4
U. picroides	3.2	998	117.0	1418	29.5	8.5
Density (plants m^{-2})						
824 (D1)	4.3	759	90.0	1498	35.8	7.9
412 (D2)	5.0	867	125.0	1389	36.6	7.9
Significance						
Species (S)	**	***	ns	ns	***	*
Density (D)	ns	ns	*	ns	ns	ns
S × D	ns	ns	ns	ns	ns	ns

Significance: ns = not significant; *, ** and ***, significant at $p \leq 0.05$, $p \leq 0.01$ and $p \leq 0.001$, respectively.

In evaluating the two species for the ready-to-eat production chain, our results suggest the possibility of obtaining the same yield with both species, and highlight the possibility of using higher density (D1) to optimize yield in both harvests (Tables 1 and 2). At the same time, the higher SPAD index of *U. delechampii*, irrespective of plant density and harvest time, should be considered. We measured SPAD index to evaluate chlorophyll content indirectly, since this pigment is important not only for visual appearance but also for human health benefits (antioxidant and antimutagenic content) [35]. From this point of view, *U. delechampii* could be preferred to *U. picroides* (Tables 1 and 2).

From a crop performance point of view, crop cycle duration of the two species was shorter for *U. picroides*, allowing earlier harvests than for *U. delechampii*. The second harvest of *U. picroides* was ready about 30 days before that of *U. delechampii* (Figure 1). The choice of *U. picroides* could therefore have an economic advantage for the production chain, namely the same yield with a shorter crop cycle.

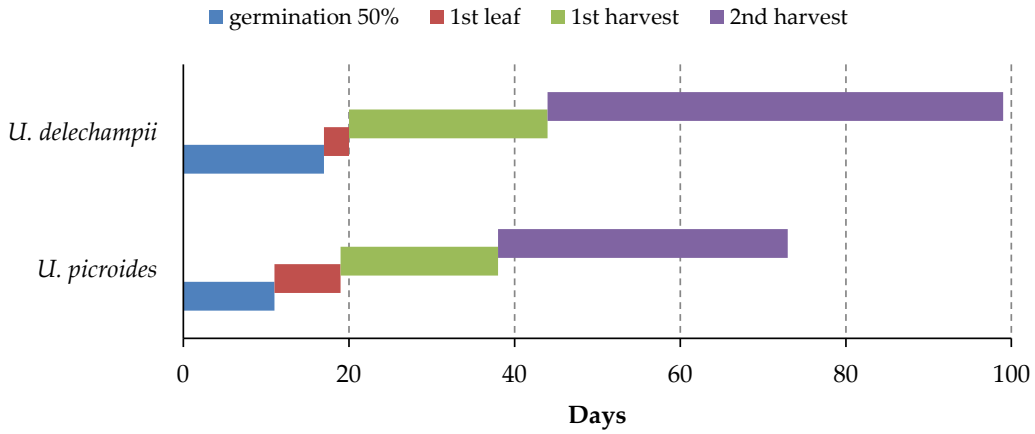

Figure 1. Crop cycle of *U. delechampii* and *U. picroides* grown in a floating system.

Finally, it is important to highlight that the leaves harvested from cultivated plants were clean (without soil particles) and, therefore, more suitable for the ready-to-eat production chain than wild plants (Figure 2). This is because the floating system allows a high hygienic standard of vegetables, besides improving growth uniformity [36].

Figure 2. *U. delechampii* grown by using a floating system (**A**) and in grasslands (**B**); *U. picroides* grown by using a floating system (**C**) and in grasslands (**D**).

3.2. Inorganic Ions Content

The interaction of species and density was not significant for ash or cations in the cultivated plants (Table 3). *U. delechampii* showed a sodium content 21% higher than *U. picroides*, while potassium and calcium were higher in *U. picroides*. At density D1, ash, sodium and potassium were 7.5%, 16% and 8% higher, respectively, than at density D2. Average magnesium content was 0.34 g 100 g^{-1} without differences in relation to species and density (Table 3).

Table 3. Ash and cation content of smooth golden fleece (*U. delechampii*) and prickly golden fleece (*U. picroides*) grown in a floating system at two sowing densities (first harvest).

	Ash	Na^+	K^+	Mg^{2+}	Ca^{2+}
	(g 100 g^{-1} d.w.)				
Species					
U. delechampii	22.2	0.81	6.86	0.34	1.54
U. picroides	22.0	0.67	7.32	0.34	1.57
Density (plants m^{-2})					
824 (D1)	22.9	0.79	7.37	0.35	1.61
412 (D2)	21.3	0.68	6.81	0.34	1.50
Significance					
Species (S)	ns	**	*	ns	***
Density (D)	*	*	*	ns	ns
S × D	ns	ns	ns	ns	ns

Significance: ns = not significant; *, ** and ***, significant at $p \leq 0.05$, $p \leq 0.01$ and $p \leq 0.001$, respectively.

Ash and magnesium contents of wild plants were 7.6 and 10.5% higher, respectively, in *U. picroides* than *U. delechampii*, while dry weight was 28% higher in *U. delechampii* (Table 4). Average contents of sodium, potassium and calcium were 1.06, 0.20 and 1.35 g 100 g^{-1} d.w., respectively, without differences between species (Table 4).

Table 4. Ash and cation content of wild smooth golden fleece (*U. delechampii*) and prickly golden fleece (*U. picroides*) gathered in grasslands.

	Dry Weight	Ash	Na^+	K^+	Mg^{2+}	Ca^{2+}
	(g 100 g^{-1} f.w.)	(g 100 g^{-1} d.w.)				
Species						
U. delechampii	9.6	13.80	1.09	3.05	0.19	1.28
U. picroides	7.5	14.85	1.03	3.12	0.21	1.42
Significance	*	*	ns	ns	*	ns

Significance: ns = not significant; * = significant at $p \leq 0.05$.

From the point of view of nutrition, we compared element intake per 100 g portion for cultivated and wild plants. For the cultivated plants, a 100 g portion of *U. delechampii* provided an average of 48 mg sodium, 404 mg potassium, 20 mg magnesium and 91 mg calcium. The same serving of *U. picroides* provided 37 mg sodium, 410 mg potassium, 20 mg magnesium and 88 mg calcium (Tables 1 and 3). The wild plants provided 104 mg sodium, 293 mg potassium, 18 mg magnesium and 123 mg calcium per 100 g of *U. delechampii* and 77 mg sodium, 234 mg potassium, 16 mg magnesium and 106 mg calcium per serving of *U. picroides* (Table 4). Potassium is an important element for humans, since it contributes to osmolarity and plays a major role in the distribution of fluids inside and outside cells. According to the European Food Safety Authority (EFSA) Panel on Dietetic Products, Nutrition and Allergies, the potassium Dietary Reference Value (DRV) is estimated at 3500 mg per day [37]. Therefore, a serving of either cultivated *U. delechampii* or *U. picroides* supplies about 12% of the average daily requirement of this element, while a serving size of wild *U. delechampii* or *U. picroides* supplies 8.4% and 6.7%, respectively. It could therefore be interesting to compare the potassium content of the present species and other plants

common in the ready-to-eat production chain. According to United States Department of Agriculture, 100 g of lettuce supplies 194 mg potassium [38], while the same sized serving of arugula supplies 369 g potassium [39]. Thus, our results suggest that the cultivated species of the present study can be considered potassium-rich vegetables. When cultivated at density D1, a 100 g portion of our plants provided 376 mg potassium, and 436 mg potassium when cultivated at density D2 (Tables 1 and 3). Our results therefore suggest that potassium content can be modulated by choosing the appropriate plant density. Regarding sodium, magnesium and calcium, we found similar percentages of daily requirements for *U. delechampii* and *U. picroides*, which were intermediate between those of lettuce and arugula [38,39]. According to García-Herrera and de Cortes Sánchez-Mata [40], our results, therefore, suggest that *U. delechampii* and *U. picroides* may be considered as a potential food source of mineral elements in the daily diet. At density D2, phosphate content was 25% higher than at density D1, while *U. picroides* showed the highest sulphate content (Table 5). The interaction between species and density was significant for nitrate and chlorine in the cultivated plants (Table 5).

Table 5. Anion content of smooth golden fleece (*U. delechampii*) and prickly golden fleece (*U. picroides*) grown in a floating system at two sowing densities (first harvest).

	NO_3^-	Cl^-	$H_2PO_4^-$	SO_4^{2-}
	(mg kg^{-1} f.w.)		(g 100 g^{-1} d.w.)	
Species				
U. delechampii	6448	1.24	1.15	0.50
U. picroides	5086	0.68	1.34	0.64
Density (plants m^{-2})				
824 (D1)	6017	0.94	0.99	0.97
412 (D2)	6109	0.71	1.24	0.93
Significance				
Species (S)	**	***	ns	*
Density (D)	*	***	*	ns
S × D	*	***	ns	ns

Significance: ns = not significant; *, ** and ***, significant at $p \leq 0.05$, $p \leq 0.01$ and $p \leq 0.001$, respectively.

Cultivated at density D2, *U. delechampii* had a nitrate content of about 7200 mg kg^{-1} f.w., which is 38% higher than in plants of the same species grown at density D1 and in plants of *U. picroides* (Figure 3).

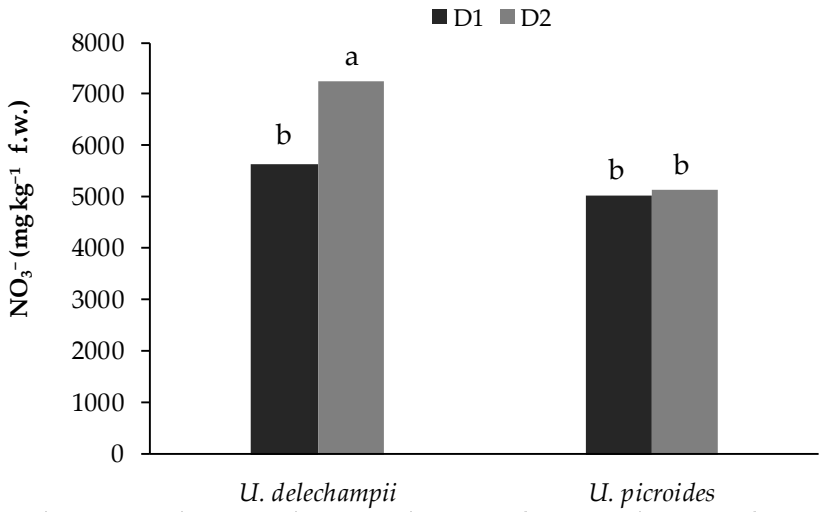

Figure 3. Nitrate content in *U. delechampii* and *U. picroides* grown at two plant densities: 824 plants m^{-2} (D1) and 412 plants m^{-2} (D2). The same letters indicate mean values not significantly different ($p = 0.05$).

Grown at density D1, *U. delechampii* showed a chloride content 50% higher than plants of the same species grown at density D2 and 119% higher than plants of *U. picroides* (Figure 4).

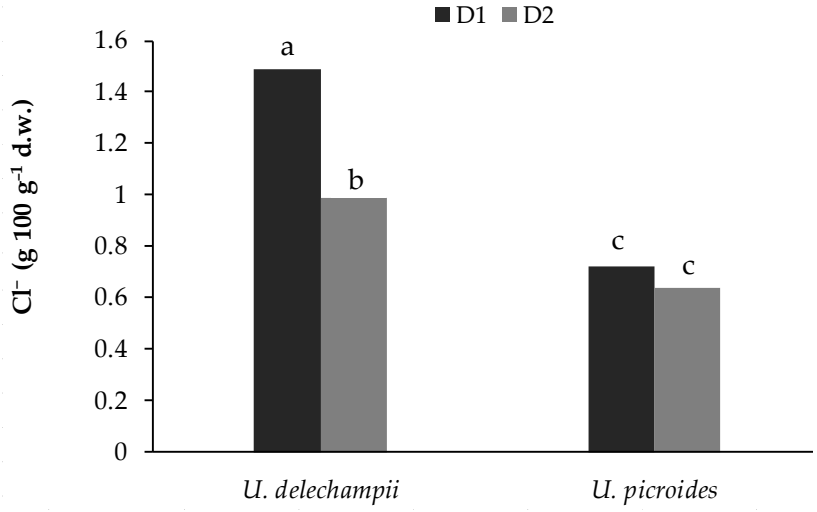

Figure 4. Chloride content in *U. delechampii* and *U. picroides* grown at two plant densities: 824 plants m^{-2} (D1) and 412 plants m^{-2} (D2). The same letters indicate mean values not significantly different ($p = 0.05$).

The interaction between species and harvest dates was significant for nitrate in wild plants (Table 6). Average chloride, phosphate and sulphate content was 4.4, 0.45 and 0.48 g 100 g^{-1} d.w., respectively, without differences between species or harvest dates (Table 6).

Table 6. Anion content of wild smooth golden fleece (*U. delechampii*) and wild prickly golden fleece (*U. picroides*) gathered in grasslands on different dates.

	NO_3^-	Cl^-	$H_2PO_4^-$	SO_4^{2-}
	(mg kg^{-1} f.w.)		(g 100 g^{-1} d.w.)	
Species				
U. delechampii	318	4.08	0.40	0.49
U. picroides	1069	4.77	0.51	0.48
Dates				
2 December	847	4.40	0.47	0.53
13 December	548	3.74	0.29	0.47
Significance				
Species (S)	*	ns	ns	ns
Dates (D)	ns	ns	ns	ns
S × D	*	ns	ns	ns

Significance: ns = not significant; * significant at $p \leq 0.05$.

U. picroides gathered on 2nd December showed a nitrate content of about 1450 mg kg^{-1} f.w., 181% higher than that of plants gathered on 13th December and 8-fold higher than plants of *U. delechampii* gathered on 2nd December (Figure 5).

Nitrate content is an important quality parameter of vegetables, and among anions can be considered the most problematic due its possible implications for human health. Nitrate *per se* is relatively non-toxic but on ingestion about 5% may be converted into nitrite and then N-nitroso compounds, which are linked to severe pathologies in humans [41]. The European Commission adopted European Regulation (EU) no. 1258/2011 that sets maximum levels for nitrates in foodstuffs [42]. For vegetables harvested from 1 October to 31 March (our study period), the Regulation set a maximum level of 7000 mg NO_3 kg^{-1} f.w. for arugula and maximum levels of 5000 and 4000 mg NO_3 kg^{-1} f.w. for lettuce grown under cover and in the open air, respectively [42]. Our results show that wild *U. delechampii*

and *U. picroides* have a substantially lower nitrate content than same species cultivated (Figures 3 and 5). This is probably due to the higher availability of nitrate to plants grown in the floating system than to wild plants growing without exogenous fertilization. According to Santamaria [41], nitrogen availability and plant genetic traits are two major factors that can affect nitrate content in vegetables. Indeed, in our study only *U. delechampii* grown at density D2 showed a higher nitrate content as a consequence of nitrogen availability and it was twice as high as in plants grown at density D1 (Figure 3). This is because for the same nitrogen supplied to the floating system, halving the number of plants increases nitrogen availability. Moreover, higher nitrate content in cultivated plants is also probably due to lower light intensity in the greenhouse. This is in line with Buttaro et al. [23], who found a higher nitrate content in arugula grown in a greenhouse covered with photovoltaic modules (not transparent) than the same species grown in a greenhouse covered with transparent modules. In the interests of quality, strategies such as removing part of leaf petioles; removing part or all nitrate nitrogen from the nutrient solution a few days before harvesting; using nutrient solutions with NO_3-N and NH_4-N rather than nitrate nitrogen alone [43] could therefore be used to reduce nitrate content in cultivated *U. delechampii* and *U. picroides* for the ready-to-eat production chain.

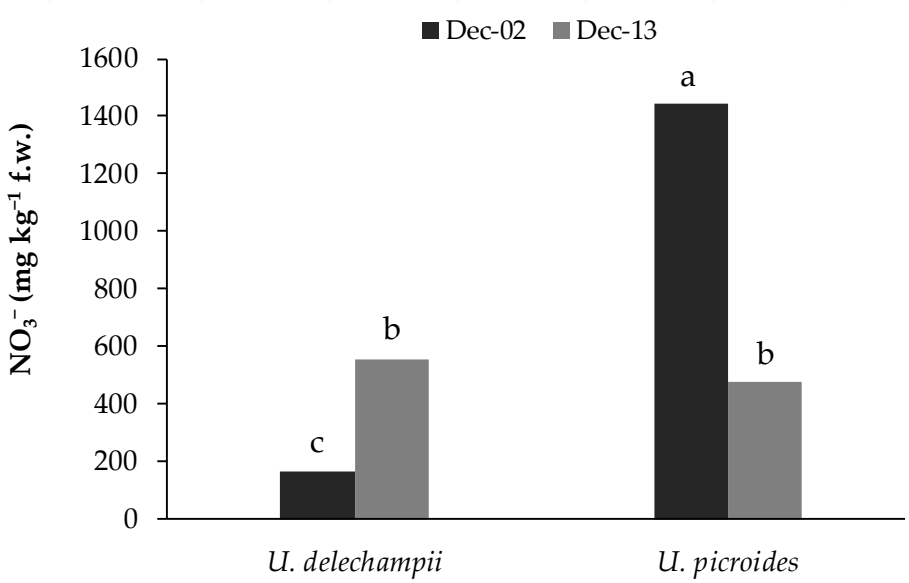

Figure 5. Nitrate content in wild *U. delechampii* and wild *U. picroides* gathered at two dates: 2 and 13 December. The same letters indicate that mean values are not significantly different (p = 0.05).

3.3. Total Phenols and Antioxidant Activity

Wild plants of the two species gathered in grasslands did not show significantly different TP and TAA values (154 ± 20, 176 ± 22 mg CAE 100 g^{-1} f.w. and 0.18 ± 0.03, 0.23 ± 0.05 g Trolox 100 g^{-1} f.w. for *U. picroides* and *U. dalechampii*, respectively). As regards cultivated plants, the interaction between species and plant density was not significant (Table 7). *U. dalechampii* showed significantly lower TP (−32%) and TAA (−53%) than *U. picroides*. At the same time, TP and TAA contents were 18 and 33% higher, respectively, in plants grown at density D2 than D1 (Table 7).

Table 7. Total phenols (TP) and total antioxidant activity (TAA) of smooth golden fleece (*U. delechampii*) and prickly golden fleece (*U. picroides*) grown in a floating system at two different sowing densities (second harvest).

	TP (mg CAE 100 g^{-1} f.w.)	**TAA (g Trolox 100 g^{-1} f.w.)**
Species		
U. delechampii	90.17	0.09
U. picroides	132.50	0.19
Density (plants m^{-2})		
824 (D1)	102.17	0.12
412 (D2)	120.50	0.16
Significance		
Species (S)	***	***
Density (D)	*	*
S × D	ns	ns

Significance: ns = not significant; * and ***, significant at $p \leq 0.05$ and $p \leq 0.001$, respectively. CAE = caffeic acid equivalent. Trolox = 6-hydroxy-2,5,7,8-tetramethylchromane-2-carboxylic acid.

Greenhouse-grown *U. dalechampii* also showed significantly lower values than wild plants (TP: −49%; TAA: −61%), while wild and greenhouse specimens of *U. picroides* did not show significant differences (Figure 6).

Our data showed a positive correlation (r^2 = 0.91) between TP and TAA values, as already reported by many authors, who showed significant correlations between phenol content and antioxidant activity in herbs and vegetables [21,44–47]. In our trials, lower phenol content and antioxidant activity were found in cultivated than in wild plants, and were sharper and more significant in *U. dalechhampii* than in *U. picroides*, thus demonstrating higher sensitivity of the former species regarding this aspect. The effect can probably be ascribed to lower luminosity in the greenhouse, in the absence of supplementary lighting, than in the open field, due to the sunlight filtering effect of the glass roof. Light is known to be a major environmental factor for the biosynthesis of phenols in plants. The physical characteristics of light used for supplementary lighting (e.g. intensity, wavelength, duration, photoperiod, etc.) play a fundamental role in eliciting as well as orientating plant metabolism, especially biosynthesis of flavonoids [48], which are reported to be common in wild edible herbs [20,21,45].

From a nutritional point of view, it is well known that phenolic compounds have an important positive role for humans. Effectively, these compounds can prevent malignancies by inhibiting the formation of nitrosamines or even decreasing their capacity for action, when they are formed. Moreover, they have antioxidant properties to be effective in preventing oxidation of the fraction low-density lipoprotein (LDL) cholesterol, thereby preventing atherosclerosis and other cardiovascular diseases [49]. Most Mediterranean wild edible plants have an average total phenol content of less than or equal to 100 mg 100 g f.w. [49]. Therefore, our results highlight that: (1) both *U. dalechhampii* and *U. picroides* can be considered a good source of phenols; (2) the total phenols content of cultivated plants in our study results similar or higher than other Mediterranean wild plants.

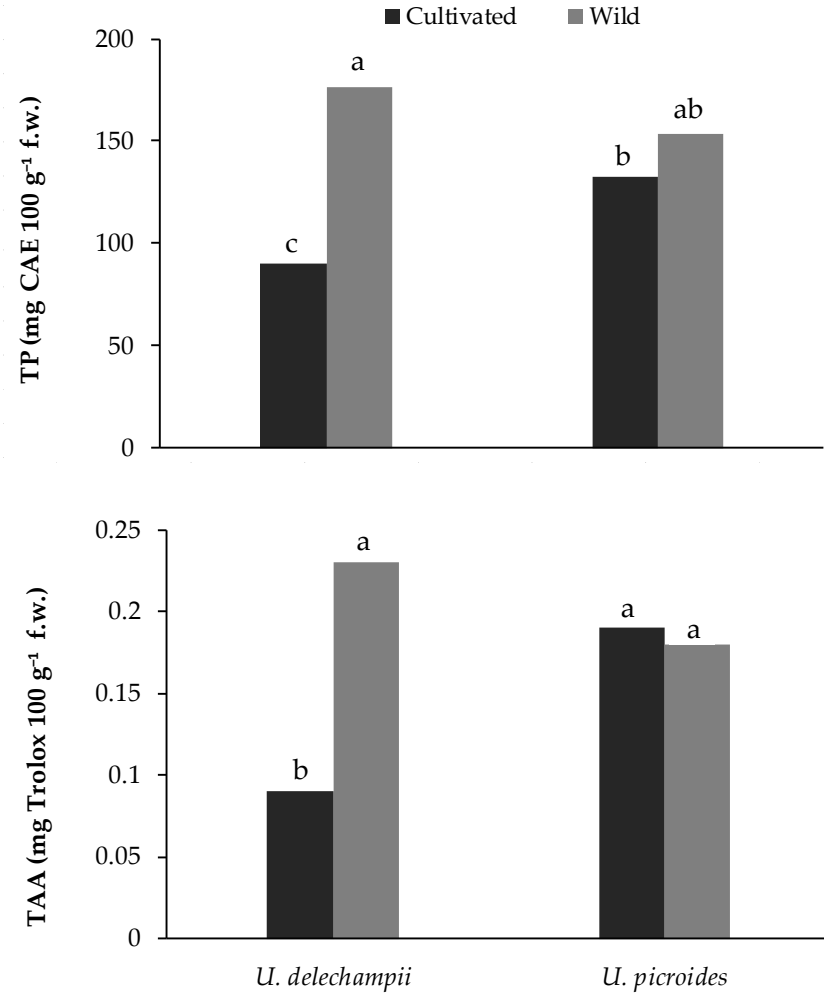

Figure 6. Total phenols (TP) and total antioxidant activity (TAA) of smooth golden fleece (*U. delechampii*) and prickly golden fleece (*U. picroides*) grown in a floating system (cultivated) and gathered in grasslands (wild). TP and TAA were considered significantly different at $p \leq 0.05$ and $p \leq 0.01$, respectively. The same letters indicate mean values not significantly different ($p = 0.05$). CAE = caffeic acid equivalent. Trolox = 6-hydroxy-2,5,7,8-tetramethylchromane-2-carboxylic acid.

4. Conclusions

The domestication of *U. dalechhampii* and *U. picroides* was tested for the first time in the present study, using a soilless system. Yield and some quality traits of these species were studied to determine their potential as vegetables for the ready-to-eat production chain. We also focused on the effect of growing the plants at two densities, comparing some quality traits between cultivated plants and wild ones. The results indicate that both species are suitable for cultivation, although *U. picroides* showed higher TP and TAA. Our results also suggest that the higher density was better for optimizing yield in two planned harvests. Since nutrient availability can be modulated and the plants harvested without soil residues, the floating system is particularly suitable for growing plants of *U. dalechhampii* and *U. picroides* for the ready-to-eat production chain. Future research may determine the optimal strength and NH_4:NO_3 molar ratio of nutrient solution to obtain the best crop performance and quality for these two species. A quality assessment of *U. dalechhampii* and *U. picroides* grown in a protected environment with supplementary lighting is another possible goal.

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D.D.V., L.S. and P.S.; writing—review and editing, M.R. and P.S.; visualization, M.R., D.D.V., L.S. and P.S.; supervision, M.R. and P.S.; project administration, P.S.; funding acquisition, P.S. All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement: Plants and seeds of *U. dalechhampii* were collected in the field with the following GPS coordinate: 41°01'59.3"N 16°53'57.4"E. Plants and seeds of *U. picroides* were collected in the field with the following GPS coordinate: 41°03'04.3"N 16°51'07.1"E.

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