The effect of sowing date on plant growth and nutritional value of *Cichorium spinosum* L. plants

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Introduction

Cichorium spinosum L. is a wild edible green, native to the Mediterranean basin, which usually grows in coastal areas and plateaus.

Mediterranean basin flora includes many native wild horticultural species, that have been used throughout the centuries as an important food and medicinal source for the rural communities (Carvahlo & Morales, 2010; Dogan, 2012). The fact that most of these species are gathered by hand from wild plants (Pereira et al., 2011; Sánchez-Mata et al., 2012), and the increasing demand for such products combined with their high market value, may result in genetic and ecological erosion (Negri, 2005).

Objectives

Evaluate for the first time the plant growth and mineral composition of *C. spinosum* for two consecutive growing periods.

Assessed parameters: leaf number, leaf fresh and dry weight, rosette diameter, leaf area, nutritional value, fatty acids composition

Materials and methods

Seeds of *C. spinosum* were sown in seed trays on 15th of October, 2013 and 17th of January, 2014 and young seedlings were transplanted on December 12th, 2013 and March 7th, 2014 respectively. Harvest took place at marketable size. Samples were analysed for proteins, fat, carbohydrates and ash using the AOAC (2005) procedures. Free sugars were determined by HPLC coupled to a refraction index detector (HPLC-RI), after adequate extraction procedure (Guimarães et al., 2013). Ca, Mg, Fe, Mn, Zn, and Cu content were determined by atomic absorption spectrophotometry and Na and K content by flame photometry. Fatty acids were determined after transesterification as described by Guimarães et al. (2013). For chlorophylls (Chl a and Chl b) content, the filtrate absorbance was measured at 453, 505, 645 and 663 nm in a spectrophotometer. Contents were calculated according to the following equations: Chl a (mg/100 mL) = 0.999 × A_{663} - 0.0989 × A_{645}; Chl b (mg/100 mL) = - 0.328 × A_{663} + 1.77 × A_{645} (Nagata & Yamashita, 1992). The experiment was laid out in a completely randomized design with each pot comprising one replicate (30 pots per treatment, 90 pots in total). Statistical analysis was performed with the aid of Statgraphics 5.1.Plus statistical package (Statistical Graphics Corporation).

Results and discussion

Leaf fresh and dry weight, and rosette diameter did not differ significantly, whereas number of leaves and total leaf area was higher in the 1st sowing (**Table 1**). According to Petropoulos et al. (2005), sowing date may have a significant effect on plant growth of leafy vegetables, such as parsley, which could consequently affect yield and quality of the final product.

Regarding mineral composition, Ca, Mg and Mn content was higher in the 2nd sowing date, whereas K and Na in the 1st sowing date (**Table 2**). Fe and Zn content was not affected by sowing date. Regarding nutritional value, ash content increased in the 2nd sowing date, whereas protein and carbohydrate content decreased (**Table 3**). However, fructose and glucose and consequently total sugars content, and ascorbic acid content increased in the 2nd sowing, whereas α-tocopherol and total tocopherols, and Chl b decreased (**Table 3**). Fatty acids consisted mainly of linoleic, α-linolenic and palmitic acids, whereas no significant differences were observed between the two sowing dates. PUFA/SFA and n-6/n-3 ratio was higher than 0.45 and lower than 4.0, for both sowing dates (**Table 4**).

According to Petropoulos et at. (2016) and Zeghichi et al. (2003a,b), growing conditions have a significant effect on chemical composition of *C. spinosum* aerial parts, with significant differences being observed between wild and conventionally and/or organically cultivated plants.

Table 1. Plant growth of *C. spinosum* plants in relation to sowing date.

Sowing	Leaf number	Leaf fresh weight (g)	Rosette diameter (cm)	Leaf area (cm^2)	Leaf dry matter (%)
1st	20.5 a	10.6 a	15.5 a	120.7 a	9.3 a
2nd	17.8 b	11.2 a	16.3 a	103.3 b	8.9 a

Table 2. Mineral composition of *C. spinosum* plants in relation to sowing date

Sowing	Ca	Mg	Mn	Fe	K	Na	Zn
1st	2.28 b	0.18 b	0.007 b	0.006 a	3.45 a	14.86 a	0.004 a
2nd	4.12 a	0.51 a	0.011 a	0.007 a	2.24 b	8.11 b	0.005 a

Table 3. Nutritional value of *C. spinosum* plants in relation to sowing date (mean ± SD).

Parameter	Units	Sowing date	
		1st	2nd
α-Tocopherol	(mg/100g fw)	0.39±0.01 a	0.26±0.01 b
δ-Tocopherol	(mg/100g fw)	0.25±0.01 a	0.22±0.01 a
Total Tocopherols	(mg/100g fw)	0.64±0.01 a	0.48±0.01 b
Ascorbic acid	(μg/100 g fw)	0.080±0.001 a	0.090±0.002 a
Chlorophyll a	(μg/100 g fw)	46.1±0.1 a	48.25±0.03 a
Chlorophyll b	(μg/100 g fw)	18.0±0.1 a	12.60±0.02 b
Humidity	(%)	90.67 a	91.10 a
Energy	(kcal/100 g fw)	36.96±0.13 a	33.97±0.01 a
Ash	(g/100 g fw)	0.45±0.04 b	0.75±0.01 a
Proteins	(g/100 g fw)	0.58±0.01a	0.49±0.01a
Fat	(g/100 g fw)	0.29±0.01a	0.27±0.01a
Carbohydrates	(g/100 g fw)	8.01±0.03 a	7.39±0.01 b
Fructose	(g/100 g fw)	0.32±0.32 a	0.39±0.38 a
Glucose	(g/100 g fw)	0.68±0.01 b	0.90±0.01 a
Sucrose	(g/100 g fw)	0.40±0.01 a	0.44±0.01 a
Total Sugars	(g/100 g fw)	1.40±0.01 b	1.73±0.01 a

Table 4. Composition in fatty acids of the studied *C. spinosum* plants in relation to sowing date (%; mean ± SD).

Parameter	Sowing date	
	1st	2nd
C6:0	0.05±0.01	0.03±0.01
C8:0	0.07±0.01	0.06±0.01
C10:0	0.10±0.01	0.07±0.01
C12:0	0.17±0.01	0.10±0.01
C14:0	0.60±0.01	0.43±0.03
C15:0	0.37±0.02	0.32±0.01
C16:0	14.18±0.82	13.25±0.45
C16:1	0.37±0.02	0.28±0.01
C17:0	0.32±0.01	0.27±0.01
C18:0	2.51±0.10	2.22±0.01
C18:1n9	2.63±0.05	2.84±0.03
C18:2n6	24.05±0.07	25.20±0.10
C18:3n3	47.96±0.27	48.99±0.15
C20:0	0.93±0.05	0.75±0.06
C20:1	0.18±0.01	0.20±0.01
C20:2	0.21±0.01	0.19±0.02
C20:3n3	0.24±0.01	0.25±0.02
C21:0	0.23±0.01	0.19±0.01
C20:5n3	0.13±0.01	0.08±0.01
C22:0	1.28±0.07	1.18±0.01
C23:0	0.46±0.04	0.47±0.02
C24:0	2.95±0.26	2.63±0.18
Total SFA (% of total FA)	24.22±0.36	21.96±0.30
Total MUFA (% of total FA)	3.19±0.03	3.33±0.04
Total PUFA (% of total FA)	72.59±0.33	74.72±0.24
PUFA/SFA	0.5	0.51
n-6/n-3	3	3.4

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