

COMPARISON OF THE CONTENT OF SOME CHEMICAL COMPOUNDS IN TWO ENDIVE CULTIVARS GROWN ON AN OPEN FIELD (*CICHORIUM ENDIVIA* L.)

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Abstract

Compared with other European countries, Poles do not eat enough leafy vegetables, or example endive, which belongs to *Asteraceae* family. In Poland, endive is not a popular vegetable and is grown only amateur gardeners.

Endive is one of the most nutritious and healthy leafy vegetables. It contains more minerals (especially phosphorus, calcium and potassium), provitamin A and vitamins B₁, B₂ and C than lettuce, which is more popular in our country. Because of its high content of bitter compounds, endive has properties that can aid digestion.

In our experiment, the content of macro- and micronutrients and nitrates in leaves of two endive cultivars was studied. One of the cultivars was Riccia a cuor ol'oro sel blondie – a botanical variety escarole (*Cichorium endivia* var. *latifolium*), with smooth leaves and the other one was Blonda a cuor plen – from the curled endive group (*Cichorium endivia* var. *crispum*) with fringed leaves. A field experiment was conducted in 2004-2006 at the Horticultural Experimental Station in Dołuje near Szczecin.

The experiment was set in a one-factorial, randomized block design with three replications. The plot area was 2.88 m² (1.80×1.60 m). Cucumber grown in manure was the forecrop.

Seeds of endive were sown in a seed-bed on 20 June (in both years of the research). Transplants were planted on an open field at the phase of 4-6 leaves on 18 July (in 2006) and on 20 July (in 2007), in 40×30 cm distance. Leaf rosettes were harvested once: on 13 September (in 2006) and 8 September (in 2007). The results were statistically analysed by Tukey's test, at the significance level of 0.05.

It was proven that the content of macro- and micronutrients in endive leaves depended significantly on a cultivar. The curled endive cultivar (var. *crispum*) was characterized by a higher content of magnesium, iron, manganese and copper, while the leaves of the escarole cultivar (var. *latifolium*) contained more phosphorus, potassium, calcium and zinc but less nitrates.

The cultivar Riccia a cuor o'oro sel blondie (from the escarole group) contained more phosphorus, potassium and calcium, as mean values for the two years of the study. Regarding phosphorus – in the first year of the study, differences in the content of this macro-nutrient were not significant. However, significantly higher accumulation of phosphorus was determined in the second year in leaves of the botanical variety escarole, the fact what was also confirmed by the mean for both years of the study. This cultivar was also characterized by a significantly higher content of potassium (on average by 47.8%) and calcium (by 7.4%) in comparison with the curled endive. However, comparing the two cultivars, significantly higher amounts of magnesium (on average 187.9 mg 100 g⁻¹ d.m.) and sodium (3.0 mg 100 g⁻¹ d.m.) were assessed in the leaves of the endive cultivar from the curled endive group.

It was proved that tested in the experiment cultivars differed significantly according to the macroelement content (Fe, Mn, Cu and Zn) in the edible parts of the plants.

Key words: endive, cultivar, macro- and micronutrient content.

PORÓWNANIE ZAWARTOŚCI WYBRANYCH SKŁADNIKÓW CHEMICZNYCH W LIŚCIACH DWÓCH ODMIAN ENDYWII (*CICHORIUM ENDIVIA* L.)

Abstrakt

W Polsce w porównaniu z innymi krajami europejskimi obserwuje się za małe spożycie gatunków należących do grupy warzyw liściowych. Jednym z takich warzyw jest endywia – z rodziny astrowatych (*Asteraceae*), roślina mało znana, uprawiana jedynie amatorsko.

Endywia należy do cennych warzyw liściowych, które charakteryzują się wysoką wartością odżywczą i prozdrowotną. W porównaniu z bardziej popularną w naszym kraju sałatką, zawiera więcej soli mineralnych (zwłaszcza fosforu, wapnia i potasu), prowitamin A oraz witamin B₁, B₂ i C. Dzięki zawartości substancji gorzkich ma działanie pobudzające trawienie.

Celem badań była ocena zawartości makro- i mikroelementów oraz azotanów w liściach dwóch odmian endywii: Riccia a cuor o'oro sel blondie, należącej do odmiany botanicznej eskariola (*Cichorium endivia* var. *latifolium*) o gładkich liściach, i Blonda a cuor plen – z grupy endywii kędzierzawej (*Cichorium endivia* var. *crispum*) o liściach fryzowanych. Doświadczenie założono w latach 2004-2006, w Warzywniczej Stacji Badawczej w Dołujach k. Szczecina.

Było to doświadczenie 1-czynnikowe, założone metodą bloków losowych, w 3 powtórzeniach. Powierzchnia poletka doświadczalnego wynosiła 2,88 m² (1,80×1,60 m). Przedplonem dla endywii był ogórek uprawiany na oborniku. Nasiona endywii wysiewano na rozsadniku 20 czerwca (w obu latach uprawy), natomiast rozsadę w fazie 4-6 liści właściwych sadzono na miejsce stałe 18 lipca (2006 r.) i 20 lipca (2007 r.), w rozstawie 40×30 cm. Zbiór rozet liściowych wykonano jednorazowo 13 września (2006 r.) i 8 września (2007 r.).

Wyniki opracowano statystycznie z użyciem testu Tukeya na poziomie istotności $\alpha=0,05$.

Stwierdzono, że zawartość makro- i mikroelementów w liściach endywii była w sposób istotny uwarunkowana zmiennością odmianową. Odmiana endywii z grupy *crispum* (kędzierzawej) odznaczała się wyższą zawartością magnezu oraz żelaza, manganu i miedzi. Liście roślin odmiany endywii z grupy *latifolium* (eskariola) zawierały więcej fosforu, potasu, wapnia i cynku, a jednocześnie mniej azotanów.

Odmiana *Riccia a cuor o'oro sel blondie* (z grupy eskariola) zawierała średnio w 2 latach badań więcej fosforu, potasu i wapnia. W odniesieniu do fosforu, w 1. roku badań różnice zawartości tego makroskładnika u obu odmian okazały się nieistotne, natomiast w 2. roku stwierdzono istotnie większą koncentrację tego pierwiastka w liściach odmiany botanicznej eskariola, co potwierdziły średnie wyniki z 2 lat badań. U tej odmiany wykazano również wyższą zawartość potasu (średnio o 47,8%) i wapnia (o 7,4%) w porównaniu z endywią kędzierzawą. Natomiast istotnie więcej magnezu (średnio 187,9 mg 100 g⁻¹ d.m.) i sodu (3,0 mg 100 g⁻¹ d.m.) zawierały liście endywii z grupy endywii kędzierzawej.

Wykazano również znaczne zróżnicowanie zawartości mikroskładników (Fe, Mn, Cu i Zn) w części jadalnej badanych odmiany endywii

Słowa kluczowe: endywia, odmiany, makro- i mikroelementy.

INTRODUCTION

Among many plant products, vegetables should play an important role in human nutrition. They provide our diet with many of healthy compounds, such as: vitamins, easily digestible carbohydrates and dietary fibre. Moreover, a diet rich in vegetables and fruit is low in fat (WOLSKI, DYDUCH 2000). The actual consumption of vegetables in Poland is 2-3-fold lower than in Greece or Spain (CIEŚLIK 2009). Moreover, Poles eat a poor range of vegetable species. Endive is a vegetable species that is hardly recognized in our country although the nutritional value of its raw leaves is much higher than that of lettuce leaves. As demonstrated by CIEŚLIK (2009), endive contains many valuable compounds, e.g. fructans (inulin), and a specific compound, i.e. intybin, which are said to have a beneficial effect on the digestive and cardiovascular systems.

The aim of our experiment was to assess the content of some chemical compounds in leaves of two endive cultivars grown in autumn.

MATERIAL AND METHODS

The present experiment was carried out in order to the content of macro- and micronutrients, and nitrates in leaves of two cultivars of endive: 'Riccia a cuor o'oro sel blondie' – a botanical variety escarole (*Cichorium endivia* var. *latifolium*), with smooth leaves and 'Blonda a cuor plen' – from the curled endive group (*Cichorium endivia* var. *crispum*) with fringed leaves.

The experiment was set in a one-factorial, randomized block design with three replications. The plot area was 2.88 m² (1.80×1.60 m). Cucumber grown in manure was the forecrop for endive. Mineral fertilization was quantified according to the results of chemical analysis of the soil samples and supplemented to the levels recommended for lettuce (SADY 2006).

Seeds of endive were sown in a seed-bed on 20 June (in both years of the research). Transplants were planted on an open field at the phase of 4-6 leaves on 18 July (in 2006) and on 20 July (in 2007), in 40×30 cm distance. Leaf rosettes were harvested once: on 13 September (in 2006) and 8 September (in 2007).

Chemical analysis of the raw plant material (inner leaves) included the content of:

- nitrates (using the standard method, in plant extract with 2% acetic acid);
- potassium, sodium and calcium (by flame photometry);
- phosphorus (by the colorimetry);
- magnesium, zinc, manganese and iron (by atomic absorption spectrophotometry, AAS).

The results were statistically analysed by the Tukey test, at a significance level of 0.05.

RESULTS AND DISCUSSION

Statistical analysis of the results concerning the macronutrient content in endive leaves showed significant cultivar-dependent differences between the amounts of elements (except phosphorus determined in 2006) – Table 1.

The cultivar *Riccia a cuor ol'oro sel blondie* (the escarole group) contained more phosphorus, potassium and calcium, shown as the means for two years of the study. The differences in the content of phosphorus in the first year of the study were not significant. However, in the second year, significantly higher accumulation of phosphorus was determined in leaves of the botanical variety *escarole*, which was confirmed by the mean for both years of the study. This cultivar was also characterized by a significantly higher content of potassium (on average by 47.8%) and calcium (by 7.4%) in comparison with the curled endive. However, comparing these cultivars, significantly higher amounts of magnesium (on average 187.9 mg 100 g⁻¹ d.m.) and sodium (3.0 mg 100 g⁻¹ d.m.) were assessed for leaves of the endive from the curled endive group.

Moreover, the cultivars tested in the experiment were characterized by the a variable content of nitrates assessed in dry matter of leaves. The level of determined nitrates varied from 733.6 (for the *escarole* cultivar in the year 2006) to 1003.0 mg 100 g⁻¹ d.m. (for the curled endive in 2007).

The results of the experiment conducted by KOUDELA and PŤRÍKOVÁ (2007) showed a wide range of differences in the nitrate accumulation in leaves of different cultivars of endive.

The data presented in Table 2 prove that the cultivars tested in the experiment differed significantly in the micronutrient composition (Fe, Mn, Cu and Zn) of the edible parts of the plants.

Table 1
Content of N-NO₃ and macronutrients in endive leaves, means for 2006-2007 (mg 100⁻¹ d.m.)

Botanical variety	N-NO ₃		P		K		Ca		Mg		Na						
	2006	2007	mean	2007	2006	2007	mean	2006	2007	mean	2006	2007					
Curled	902.4	1003.0	952.7	692.0	4357.2	3942.0	4149.6	796.2	764.0	780.1	180.6	195.1	187.9	2.7	3.2	3.0	
Escarole	733.6	841.4	787.5	621.6	6121.3	6140.8	6131.1	873.9	802.2	838.1	132.5	143.3	137.9	1.9	2.3	2.1	
LSD at $\alpha=0.05$	77.64	49.64	15.56	n.s.	61.19	24.86	602.8	624.3	599.2	34.37	25.46	48.20	24.37	49.64	10.20	0.14	0.19

Table 2
Content of micronutrients in endive leaves, means for 2006-2007 (mg kg⁻¹ d.m.)

Botanical variety	Fe		Mn		Cu		Zn					
	2006	2007	2006	2007	2006	2007	2006	2007				
Curled	198.8	250.1	224.4	34.8	39.2	37.0	13.1	12.9	13.0	29.2	37.5	33.4
Escarole	105.0	195.2	150.1	29.3	31.3	30.3	12.3	12.0	12.2	31.8	48.5	40.2
LSD at $\alpha=0.05$	63.64	18.20	20.83	0.20	0.38	0.31	0.25	0.12	0.17	n.s.	3.56	5.35

The content of iron varied from 105.0 (the botanical variety escarole in 2006) to 250.1 mg 100 g⁻¹ d.m. (the curled endive cultivar in 2007). Statistical analysis of the results showed a significantly higher iron concentration in leaves of the cultivar *Blonda a cuor plen*, which was also characterized by a significantly higher content of manganese (on average 37 mg 100 g⁻¹ d.m.) and copper (on average 13 mg 100 g⁻¹ d.m.). However, leaves of *Riccia a cuor ol'oro sel blondie* contained significantly more zinc (on average 40.2 mg kg⁻¹ d.m.).

In the Department of Horticulture of the Wrocław University of Environmental and Life Sciences, there was a research project conducted to estimate the biological value of fourteen cultivars of endive (from the curled endive and escarole groups) grown in spring and autumn (ADAMCZEWSKA-SOWIŃSKA, UKLAŃSKA 2009a, UKLAŃSKA, ADAMCZEWSKA-SOWIŃSKA 2010). The authors proved a significant effect of the experimental factors on the content of macronutrients in endive leaves. Curled endive cultivars (independently of the planting date) contained higher amounts of magnesium. However, cultivars of the escarole type were characterized by a high content of calcium, what was also proved in the present study. In another experiment by the same authors (ADAMCZEWSKA-SOWIŃSKA, UKLAŃSKA 2009b), it was demonstrated that, independently of nitrogen doses, plants of the cultivar *Excel* contained more nitrates, while cv. *Cigal* had more dry matter, vitamin C and chlorophyll. In the research carried out by KOUDELA and PŤRÍKOVA (2007) it was found that cultivars of curled endive were characterized by a higher content of dry matter and fibre than cultivars from the escarole group.

CONCLUSIONS

1. The content of macro- and micronutrients in leaves of endive depended on a cultivar type.
2. The endive cultivar *Blonda a cuor plen* (from the *crispum* group) was characterized by a higher content of magnesium, iron, manganese and copper. The leaves of endive from the *latifolium* group contained more phosphorus, potassium, calcium and zinc but less nitrates.

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