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CONTENT OF MINERAL COMPONENTS IN ROOTS OF SELECTED CULTIVARS OF BEETROOT

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Abstract

Red beet is a very popular root vegetable in Poland. It is easily available on the market all year round, both as a fresh and processed product. Considering the level of consumption, red beet is the third most popular vegetable, after cabbage and carrot. It is easy to grow, produces high yields and is suitable for long term storage. It is also a vegetable characterized by very a high nutritional and dietetic value, rich in vitamins, minerals, proteins and organic acids. The actual quantities of these chemical compounds are mostly affected by a red beet cultivar, yield quantity and its quality.

The aim of the study has been to estimate the effect of red beet cultivars of different storage root shapes on some quality characteristics of the yield and on the content of macro- and micronutrients in the roots. The experiment was conducted at the Vegetable Experimental Station in Dołuje in 2004-2006. In mid-May each year, seeds of ten red beet cultivars in the amount of 16 kg ha^{-1} were sown in rows spaced at 30 cm. The beetroots were harvested in the third decade of September.

The results proved that the highest ratio of root to leaf mass was determined for the cultivar Rocket (on average 73.1%). In each year, the highest unit root weight was noted for the cultivars Opolski and Rocket. These two cultivars were also characterized by the highest content of dry matter (12.9 and 13.1%, respectively). In contrast, the least amount of dry matter was determined for the cultivars Bikores and Chrobry (10.5 and 10.6%). There were no significant differences assessed in the content of macronutrients (N, P, K, Ca, Mg and Na). However, there was a significant influence of the cultivars on the content of micronutrients. Among the cultivars tested in the experiment, the highest content of manganese was determined in cv. Czerwona Kula, zinc in cv. Bikores, iron in cv. Egipski and Czerwona Kula. Roots of cv. Czerwona Kula were also characterized by the highest content of copper in comparison with the other cultivars.

Key words: beetroot, macro- and microelements content.

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ZAWARTOŚĆ SKŁADNIKÓW MINERALNYCH W KORZENIACH SPICHRZOWYCH WYBRANYCH ODMIAN BURAKA ĆWIKŁOWEGO

Abstrakt

Burak ćwikłowy jest w Polsce warzywem o podstawowym znaczeniu, dostępnym na rynku przez cały rok w postaci świeżej lub przetworzonej. Pod względem wielkości spożycia zajmuje trzecie miejsce po kapuście i marchwi. Jest łatwy w uprawie, niezawodny w plonowaniu, doskonale się przechowuje. Należy jednocześnie do gatunków o wysokiej wartości odżywczej i dietetycznej. O wartości zdrowotnej, dietetycznej i odżywczej warzyw decyduje m.in. zawartość witamin, soli mineralnych, białka, kwasów organicznych. Zawartość tych składników jest w dużej mierze uzależniona od odmiany oraz wielkości i jakości plonu.

Celem pracy była ocena wpływu odmian buraka ćwikłowego o zróżnicowanych kształtach korzenia spichrzowego na wybrane cechy jakościowe plonu oraz zawartość makro- i mikroelementów. Doświadczenie założono w latach 2004-2006 w Warzywniczej Stacji Badawczej w Dołujach. Nasiona 10 odmian wysiewano w połowie maja, w ilości 16 kg ha^{-1}, w rzędy co 30 cm, korzenie zbierano w ostatniej dekadzie września.

Na podstawie badań stwierdzono największy udział masy korzeni w stosunku do masy liści w odniesieniu do odmiany Rocket (średnio 73,1%). W każdym roku badań największą masę jednostkową korzeni spichrzowych miały odmiany Opolski i Rocket. U tych odmian stwierdzono jednocześnie najwięcej suchej masy (odpowiednio: 12,9 i 13,1%). Najmniej zasobne w suchą masę były odmiany Bikores i Chrobry (10,5 i 10,6%). U badanych odmian nie wykazano istotnego zróżnicowania zawartości makroelementów (N, P, K, Ca, Mg i Na), natomiast stwierdzono istotny wpływ odmian na poziom wybranych mikroelementów w części jadalnej buraka. Spośród ocenianych odmian najwięcej manganu zawierała odmiana Czerwona Kula, a najwięcej cynku miały korzenie odmiany Bikores. Najbardziej bogate w żelazo były korzenie odmian Egipski i Czerwona Kula. U tej ostatniej odmiany wykazano również największą w porównaniu z pozostałymi odmianami zawartość miedzi.

Słowa kluczowe: burak ćwikłowy, zawartość makro- i mikroelementów.

INTRODUCTION

Red beetroot is one of the most important vegetables in Poland, available all year round, fresh or processed. It is the third vegetable, after cabbage and carrot, in respect of the amount consumed. Beetroot is easy to grow and produces stable yields. It is one of the vegetables of high nutritive value (BARAŃSKI, GRZEBELUS 1998). Roots of beetroot contain 89.0% water, 1.5% protein, 7.58% carbohydrates, 1.0% mineral components (calcium, phosphorus, potassium, manganese, iron), vitamins (provitamin A, vitamins from B group, vitamin C) and organic acids. According to KRYŃSKA and MARTYNIAK (1978), the cultivar, quantity and quality of yield affect the content of these components.

The aim of our experiment has been to examine the influence of selected cultivars of beetroot on the quality traits of storage roots and the content of macro- and micronutrients.

MATERIAL AND METHODS

The experiment was carried out in 2004-2006 at the Department of Vegetable Crops, the Agricultural University in Szczecin. Ten cultivars of beetroot with flattened (Egipski and Patryk), round or oval (Bikores, Chrobry, Crosby, Czerwona Kula and Nochowski) or elongated roots (Opolski and Rocket) were tested. A single- factor experiment was conducted in a randomized block design with four replicates. Each experimental plot was 2.4 m^2 (2.0×1.2 m) in area. On 15th May, seeds of each of the ten beetroot cultivars in the amount of 16.6 kg ha^{-1} were sown in rows 30 cm apart.

Roots were harvested in the last decade of September. The content of dry matter (by drying to the stable weight at 105ºC) and concentrations of mineral components (N – determined by Kjeldahl method, P – colorimetric method, K, Na and Ca – flame photometry method, Cu, Zn, Mn, Fe and Mg – flame method of atomic spectrophotometry absorption ASA), were determined in the harvested marketable yield. The results were verified statistically using Tukey's test at the significance level α=0.05.

RESULTS AND DISCUSSION

The results showed that the cultivars Opolski and Rocket were characterized by the highest mean weight of storage roots in the first year of the experiment (Table 1). In the next two years, cv. Opolski (with elongated roots) was characterized by the significantly highest weight of roots.

Table 1

Mean weight of storage root of ten cultivars of red beetroot cultivated for autumn harvest (g)

Cultivar	Years		
	2004	2005	2006
With flattened roots			
Egipski	219.4	235.8	224.6
Patryk	250.7	243.6	287.4
With round or oval roots			
Bikores	246.4	237.2	285.1
Chrobry	289.9	212.8	284.5
Crosby	213.8	236.6	220.5
Czerwona Kula	223.1	238.9	229.9
Nochowski	251.6	239.8	265.7
Pablo F1	210.4	226.3	270.5
With elongated roots			
Opolski	345.3	256.2	397.5
Rocket	305.3	302.6	296.0
LSD α=0.05	44.990	53.184	47.30

Table 2

Content of selected micronutrients in storage roots of red beetroot cultivars (in % of dry matter) – mean for 2004-2006

Cultivar	N	P	K	Mg	Ca	Na
With flatted roots						
Egipski	0.93	0.21	2.24	0.11	0.12	0.09
Patryk	1.08	0.11	2.28	0.12	0.22	0.07
With round roots						
Bikores	0.91	0.22	2.20	0.21	0.21	0.09
Chrobry	0.90	0.24	2.45	0.12	0.14	0.08
Crosby	0.95	0.24	2.54	0.14	0.14	0.11
Czerwona Kula	0.80	0.26	2.20	0.10	0.12	0.07
Nochowski	0.92	0.31	2.31	0.12	0.11	0.07
Pablo F1	0.90	0.21	2.71	0.11	0.22	0.10
With elongated roots						
Opolski	0.72	0.21	2.23	0.13	0.23	0.09
Rocket	1.15	0.20	2.80	0.14	0.22	0.11
LSD α=0.05	0.232	n.s	0.131	n.s	n.s	n.s

n.s.-non-significant differences

Concentrations of the mineral components in storage roots of the ten beetroot cultivars, expressed in dry matter of raw material, are given in Tables 2 and 3. Roots of cv. Rocket were characterized by a significantly higher content of total N in comparison with cv. Bikores, Chrobry, Pablo F_1, Czerwona Kula and Opolski. No significant differences in the content of P, Mg, Ca and Na in roots of the examined cultivars were found. However, the cultivars differed significantly in the content of the micronutrients in edible parts of beetroot (Table 3). In the years of the experiment, significantly more Mn was found in storage roots of cv. Czerwona Kula. The lowest content of Mn was determined in roots of cv. Nochowski, Patryk, Rocket and Pablo F_1 in 2005 and in roots of cv. Pablo F_1 and Crosby in 2006. The significantly highest content of Zn for the whole experiment was assessed in edible parts of cv. Pablo F_1, Rocket and Egipski. The significantly highest content of iron for the whole experiment was determined in roots of cv. Egipski. The roots of cv. Rocket were characterized by the lowest content of iron.

The red beet cultivar Czerwona Kula was characterized by the significantly highest content of copper. The other cultivars did not differ significantly in the content of this micronutrient.

The uptake of mineral components by plants depends not only on the conditions of cultivation (Jędrzejczak et al. 1999, Perucka 1999, Szura et al. 2008) but also on the species and cultivar (Kotowska, Wybieralski 1999). This observation was confirmed by the results of our experiment. Also Jadczak and Grzeszczuk (2004) described significant differences in the content of macro- and micronutrients in fruits of selected cultivars of hot pepper.

Table 3

Content of selected micronutrients in storage roots of red beetroot cultivars

Cultivar	Content of micronutrients (mg kg^{-1} d.m.)											
	Mn			Zn			Fe			Cu		
	2005	2006	mean	2005	2006	mean	2005	2006	mean	2005	2006	mean
With flatted roots												
Egipski	17.0	13.7	15.3	20.9	21.0	21.0	163.1	206.0	184.6	6.5	9.5	8.0
Patryk	13.7	16.2	14.9	26.2	31.0	28.6	164.0	140.9	152.5	5.8	7.0	6.4
With round roots												
Bikores	18.9	16.2	18.1	31.8	44.9	38.4	129.0	117.9	123.5	5.6	7.1	6.4
Chrobry	18.4	16.3	17.4	28.2	29.0	28.6	176.6	101.0	138.8	5.2	6.8	6.0
Crosby	15.4	11.2	13.3	26.4	28.1	27.3	143.0	162.2	152.6	6.2	6.8	6.5
Czerwona Kula	24.6	23.6	24.1	32.3	30.1	31.2	188.0	109.0	148.5	9.0	12.9	11.0
Nochowski	14.5	16.2	15.3	28.1	38.2	33.2	129.0	78.8	103.9	6.5	8.0	7.3
Pablo F1	12.4	12.5	12.4	23.3	24.4	23.9	164.1	148.0	156.1	5.8	8.1	7.0
With elongated roots												
Opolski	20.3	18.5	19.4	38.0	28.8	33.4	129.8	99.8	114.8	5.0	6.9	6.0
Rocket	12.9	15.0	14.0	21.5	20.6	21.1	98.8	102.0	100.4	5.7	6.6	6.2
LSD α=0.05	2.80	2.86	1.77	3.57	5.42	2.87	15.79	15.16	9.67	1.90	3.07	1.98

CONCLUSIONS

1. Roots of the examined cultivars of beetroot different significantly in the content of N, K, Mn, Zn, Fe and Cu.

2. Among the examined micronutrients, roots of beetroot contained the highest amount of iron (on the average 137.6 mg kg^{-1} d.m.).

3. The cultivars Rocket, Patryk, Crosby, Egipski and Nochowski were characterized by the highest content of total N.

4. Roots of the cultivars Rocket and Pablo F_1 were characterized by the highest content of potassium.

5. The significantly highest content of Mn and Cu was estimated in storage roots of cv. Czerwona Kula.

REFERENCES

BARAŃSKI R., GRZEBELUS D., 1998. *Badanie zawartości cukrów, barwników i azotanów w populacjach F_2 otrzymanych z krzyżowań między burakiem ćwikłowym i cukrowym [Examination of the content of sugars, pigments and nitrates in F_2 populations obtained by crossing red beetroot and sugar beet].* Zesz. Nauk. AR Kraków, 333:49-52. (in Polish)

JADCZAK D., GRZESZCZUK M. 2004. *Zawartość składników mineralnych w owocach wybranych odmian papryki ostrej i półostrej (Capsicum annum L.) [Content of mineral elements in fruit of some cultivars of hot and semi-hot peppers].* J. Elementol., 9 (1):|15-23. (in Polish)

JĘDRZEJCZAK R., RĘCZAJSKA A., SZTEKE B. 1999. *Magnez i inne makroelementy w roślinnych surowcach jadalnych [Magnesium and other macronutrients in plant edible raw products].* Biul. Magnezol., 4(1): 72-76. (in Polish)

KOTOWSKA J., WYBIERALSKI J. 1999. *Kształtowanie się stosunków ilościowych K, Ca i Mg w glebie oraz roślinnych [Formation of quantitative ratios between K, Ca and Mg in soil and in plants].* Biul. Magnezol., 4(1): 104-110. (in Polish)

KRYŃSKA W., MARTYNIAK B. 1978. *Wartość odżywcza kapusty wczesnej i pomidorów uprawianych na terenie falistym [Nutritive value of early cabbage and tomatoes grown in undulated area].* Rocz. Nauk Rol. Ser. A, 103(4):79-92. (in Polish)

PERUCKA I. 1999. *Akumulacja Ca, Zn i N ogólnego w częściach nadziemnych papryki ostrej traktowanej etanolem [Accumulation of Ca, Zn and total N in aerial parts of hot pepper treated with ethanol].* Biul. Magnezol., 4(3/4): 526-530. (in Polish)

SZURA A., KOWALSKA J., SADY WE.2008. *The content of mineral and protein nitrogen in red beet depending on nitrogen fertilizer type and fertilization method.* Acta Sci. Pol., Hort. Cult., 7(3): 3-14.