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SELECTED INDICATORS OF THE ROOT QUALITY OF FIFTEEN CULTIVARS OF RED BEET (*BETA VULGARIS* L.)

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ABSTRACT

Evaluation of the quality of 15 cultivars of red beet has been made during four successive vegetative seasons. The study involved cultivars ‘Astar F$_1$’, ‘Boro F$_1$’, ‘Ceryl’, ‘Chrobry’, ‘Czerwona Kula’, ‘Egipski’, ‘Karmazyn’, ‘Nabab F$_1$’, ‘Nochowski’, ‘Opolski’, ‘Pablo F$_1$’, ‘Patryk’, ‘Regulski Cylinder’, ‘Okrągły Regulski’ and ‘Rywal’. The mass, diameter of roots, antioxidant activity, the content of dry mass, soluble sugars, betanin and vulgaxanthin in roots were evaluated. The study indicated ‘Chrobry’ as the cultivar of the most favorable quality features. It was characterized by high antioxidant activity, high content of dry mass, soluble sugars and betalain pigments. Among cultivars of cylindrical shaped roots, content of soluble sugars and antiradical activity was the highest in ‘Regulski Cylinder’ roots.

Key words: red beet, cultivars, antioxidant activity, betalain pigments, soluble sugars

INTRODUCTION

Red beet is one of the most popular vegetable in Poland. It belongs to the group of 10 vegetables showing the highest antioxidant potential (Vinson et al. 1998; Wettasinghe et al. 2002). Its health benefits are primarily owed to betalaine compounds, which provide protection against reactive forms of oxygen and other free radicals. Due to their natural origin, they contribute to greater protection of human body against carcinogenic substances than their synthetic substitutes (Stintzing & Carle 2007). These pigments belong to two groups: red-violet betacyanins and yellow betaxanthins. Betacyanins are mainly betanin and izobetanin, while among betaxanthins mainly vulgaxanthins (I and II) can be distinguished (Strack et al. 2003). Betacyanins belong to the group of natural antioxidants, and betanin is commonly called a “rising star among antioxidants” (Nowak et al. 2008). However, no clear connection between the presence of yellow pigments and antioxidant capacity has been observed (Czapski et al. 2009). Betanin present in red beets, marked with E-162, is also used in the production of natural pigments (Bruch-Kowalska & Wąsik 1995).

The red beet roots consist mainly of reducing sugars such as glucose and fructose, disaccharides and starch (Zadernowski & Oszmiański 1994). They are also characterized by a high content of roughage (Wiąckowski 1995) that belongs to the carbohydrates beneficial for the digestive processes.

The purpose of this study was to evaluate the quality of 15 cultivars of red beet based on the content of soluble sugars, dry mass, betalain pigments and antioxidant properties. Also the mass, root diameter and the content of juice in red beets were assessed.

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MATERIALS AND METHODS

The study was carried out in 2009-2012 in the experimental field of the Department of Vegetable and Medicinal Plants in Mydlniki near Kraków on brown soil. For this study 15 cultivars of red beet from different breeding companies have been rated. Thirteen cultivars, 'Astar F_1', 'Boro F_1', 'Ceryl', 'Chrobry', 'Czerwona Kula', 'Egipski', 'Karmazyn', 'Nabab F_1', 'Nochowski', 'Opolski', 'Pablo F_1', 'Patryk', 'Regulski Cylinder', 'Okrągły Regulski' and 'Rywal' were bred in Poland, and 'Boro F_1' and 'Pablo F_1' – in the Netherland.

Before sowing, seeds were coated with Funaben T. They were sown in rows at intervals of 40 cm using a seeder. After about 2-4 weeks (depending on the year) thinning was performed at intervals of about 10 cm, so there were 25 plants per square meter. The experimental plots of 6 m^2 were arranged in a randomized block with four replications. During the growing season, a mechanical weeding was performed continuously. In the late July and early August a treatment against *Cercospora beticola* was administered with the use of Curzate fungicide, containing cymoxanil as active ingredient (20 g of the product per 10 liters of water).

The seeds were sown in early July, seedlings were thinned in middle or late July and roots were harvested in October in 2010, and in September in the remaining years.

Immediately after harvest, the root fresh weight and diameter, content of juice and the dry mass by method of Pijanowski at 70 °C (Krełowska-Kułas 1993) were performed. Content of soluble sugars was (% f.w.) determined by anthrone method (Yemm & Wills 1954), betanin and vulgaxanthin ($mg \cdot g^{-1}$ f.w.) according to Nilsson (1970) and the antioxidant activity of the stable radical DPPH (2,2-diphenyl-2-picrylhydrazyl) according to Miliauskas et al. 2004.

Al total of 40 representative roots was taken from each cultivar, based on which chemical analysis was performed. Analyses for each cultivar were performed in triplicate. Obtained results were statistically worked out with Statistica 9.0 software, using the analysis of the Tukey HSD test at a level of significance, $p = 0.05$.

RESULTS AND DISCUSSION

The weather conditions in years 2009 and 2012 differed largely. Extremely adverse climatic events were observed in the second year of the study. These included a great amount of rainfall throughout the whole period of vegetation, especially high in the last ten days of July and August when the field was flooded for some time. The least precipitation was in 2012. The highest temperatures occurred in July of 2009, 2010 and 2012 and in August 2011. The period from 10 to the 20 July 2010 was the warmest. However, the coolest period was in middle October of the same year (Figs. 1-4). It has been shown that in the year of the highest rainfall (2010) the content of vulgaxanthine and betanine in beet roots was significantly lower compared with 2012, in which there was the least rainfall.

Results from years 2009 and 2012 showed that the largest root diameter had Egipski cultivar, although there were no significant differences between 'Ceryl' and 'Boro F_1' cultivars (Table 1). At the same time, this cultivar was characterized by the lowest antioxidant ability and the lowest content of betanin and vulgaxanthin among examined cultivars (Table 6, 7), which is consistent with studies of Watson and Gabelman (1982) who showed that red beets with higher mass contain about 20% less pigments than those of medium size.

Among the analysed cultivars, 'Nabab F_1' proved to be the least juicy (Table 4). It was also characterized by a low level of sugars and high content of dry mass (Table 3, 5); therefore, it should not be recommended for juice or borscht production. There were no substantial differences in dry mass contents within the examined cultivars (Table 3). The highest content of soluble sugars was found in 'Ceryl', yet it did not vary greatly from the cultivars 'Astar F_1', 'Boro F_1', 'Chrobry', 'Egipski' and 'Okrągły Regulski'. The lowest content of sugars was noticed in 'Nabab F_1' and 'Karmazyn' (Table 5). In comparison to the study of Elkner et al. (1997), in our experiment 'Czerwona Kula' and 'Chrobry' evidenced a lesser content of dry mass and soluble sugars, which could be a reason of diverse crop conditions.

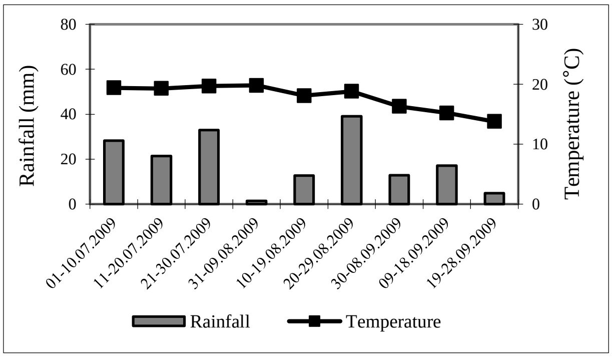

Fig. 1. Average temperatures and rainfall sum in 2009, for periods of 10 days

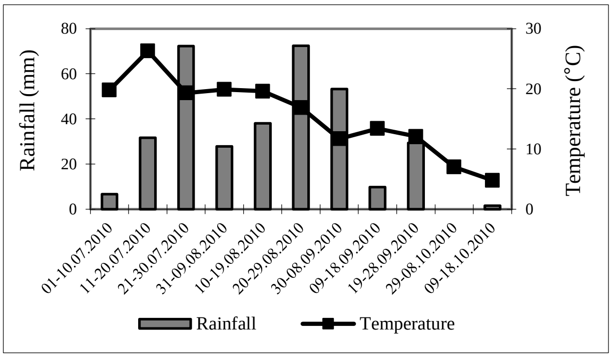

Fig. 2. Average temperatures and rainfall sum in 2010, for periods of 10 days

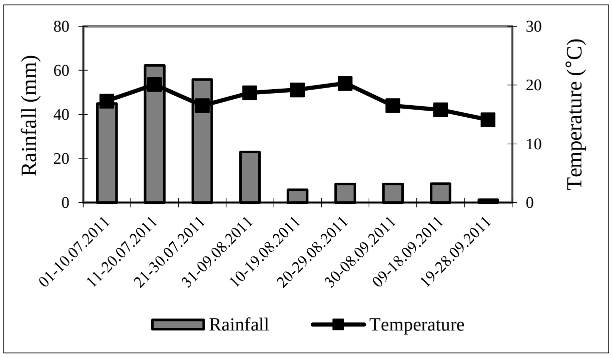

Fig. 3. Average temperatures and rainfall sum in 2011, for periods of 10 days

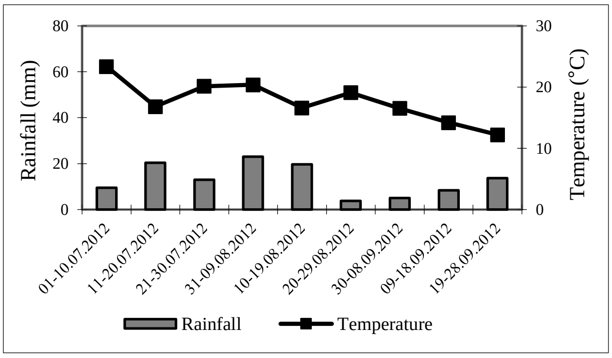

Fig. 4. Average temperatures and rainfall sum in 2012, for periods of 10 days

Table 1. Diameter of roots (cm) of 15 red beet cultivars in 2009-2012

Cultivar	2009	2010	2011	2012	Mean
‘Astar F_1’	6.73 c	6.41 bc	5.10 abc	5.50 cde	5.94 B
‘Boro F_1’	7.66 ef	6.62 c	5.70 cde	6.19 de	6.54 CD
‘Ceryl’	7.98 f	6.42 bc	6.07 cde	5.72 cde	6.55 CD
‘Chrobry’	6.83 cd	5.88 bc	5.65 cd	5.00 bc	5.84 B
‘Czerwona Kula’	7.87 f	5.99 bc	5.54 bcd	5.42 bcde	6.21 BC
‘Egipski’	8.96 g	8.04 d	6.73 e	5.74 cde	7.37 D
‘Karmazyn’	7.53 ef	4.03 a	5.80 cde	5.67 cde	5.76 B
‘Nabab F_1’	7.49 ef	5.63 b	5.57 cd	5.72 cde	6.10 BC
‘Nochowski’	7.30 de	6.35 bc	6.21 de	5.27 bcd	6.28 BC
‘Opolski’	5.12 a	3.97 a	4.21 a	5.28 bcd	4.65 A
‘Pablo F_1’	7.42 ef	6.75 c	5.84 cde	3.69 a	5.93 BC
‘Patryk’	7.59 ef	6.18 bc	5.71 cde	6.45 e	6.48 BC
‘Regulski Cylinder’	4.75 a	4.32 a	4.25 a	4.68 abc	4.50 A
‘Regulski Okrągły’	7.57 ef	6.03 bc	6.03 cde	5.67 cde	6.32 BC
‘Rywal’	6.04 b	4.04 a	4.51 ab	4.38 ab	4.74 A
Annual mean	7.12 B	5.78 A	5.53 A	5.36 A	5.95

For $p = 0.05$ (Tukey test), significant differences are marked with different letters

Table 2. Fresh weight of roots (g) of 15 red beet cultivars in 2009-2012

Cultivar	2009	2010	2011	2012	Mean
‘Astar F_1’	175 ab	168 cde	90.2 a	93.9 abcd	132 ABC
‘Boro F_1’	337 bc	169 cde	144 bc	140 cd	197 CD
‘Ceryl’	239 c	150 abcde	132 abc	107 abcd	157 ABC
‘Chrobry’	237 bc	129 abcd	137 abc	79.5 ab	145 ABC
‘Czerwona Kula’	279 bc	134 abcd	112 abc	90.1 abc	154 ABC
‘Egipski’	297 bc	182 de	108 ab	80.4 ab	167 BC
‘Karmazyn’	234 bc	106 a	106 ab	104 abcd	137 ABC
‘Nabab F_1’	280 bc	104 a	110 ab	109 bcd	151 ABC
‘Nochowski’	224 bc	162 bcde	142 abc	75.2 ab	151 ABC
‘Opolski’	67.8 a	113 a	108 ab	79.6 ab	92.2 A
‘Pablo F_1’	567 d	200 e	131 abc	70.5 ab	242 D
‘Patryk’	243 bc	127 abc	98.7 ab	145 d	154 ABC
‘Regulski Cylinder’	83.7 a	140 abcd	137 abc	57.5 a	105 AB
‘Okrągły Regulski’	303 c	117 abc	119 abc	108 abcd	161 BC
‘Rywal’	304 c	104 a	163 c	121 bcd	173 C
Annual mean	258 A	140 A	123 A	97.2 A	155

For p = 0.05 (Tukey test), significant differences are marked with different letters

Table 3. Content of dry matter in roots (%) of 15 red beet cultivars in 2009-2012

Cultivar	2009	2010	2011	2012	Mean
‘Astar F_1’	14.9 gh	16.6 f	14.7 ef	13.6 def	14.9 A
‘Boro F_1’	12.4 a	16.1 e	12.8 ab	12.6 bcd	13.5 A
‘Ceryl’	14.3 f	17.6 i	14.8 fg	13.5 def	15.1 A
‘Chrobry’	15.5 j	16.9 g	14.8 efg	14.0 ef	15.3 A
‘Czerwona Kula’	13.7 c	15.8 d	14.9 g	12.6 bcd	14.3 A
‘Egipski’	13.6 c	17.1 h	14.6 e	13.5 def	14.7 A
‘Karmazyn’	15.0 h	15.0 a	15.6 i	14.0 ef	14.9 A
‘Nabab F_1’	15.4 i	17.0 gh	15.5 i	13.4 cde	15.3 A
‘Nochowski’	15.0 h	16.9 gh	14.6 ef	14.6 f	15.3 A
‘Opolski’	13.8 d	16.7 f	14.8 efg	13.4 def	14.7 A
‘Pablo F_1’	12.6 b	16.6 f	13.1 c	11.5 ab	13.5 A
‘Patryk’	14.9 f	17.6 i	14.3 d	11.0 a	14.4 A
‘Regulski Cylinder’	14.0 e	15.2 b	12.7 a	13.6 def	13.9 A
‘Regulski Okrągły’	14.1 e	18.1 j	15.2 h	12.1 ab	14.9 A
‘Rywal’	13.6 c	15.5 c	13.0 bc	12.2 bc	13.6 A
Annual mean	14.2 A	16.6 B	14.4 A	13.0 A	14.5

For p = 0.05 (Tukey test), significant differences are marked with different letters

Table 4. Content of juice (ml·kg^{-1} f.w.) in roots of 15 red beet cultivars in 2009-2012

Cultivar	2009	2010	2011	2012	Mean
‘Astar F_1’	460	500	540	300	450
‘Boro F_1’	460	540	540	270	453
‘Ceryl’	570	450	450	240	428
‘Chrobry’	440	490	490	230	413
‘Czerwona Kula’	510	450	450	270	420
‘Egipski’	470	490	490	200	413
‘Karmazyn’	490	490	480	200	415
‘Nabab F_1’	440	370	400	240	363
‘Nochowski’	500	430	480	220	408
‘Opolski’	510	410	440	280	410
‘Pablo F_1’	550	520	550	200	455
‘Patryk’	580	440	420	300	435
‘Regulski Cylinder’	530	550	590	200	468
‘Regulski Okrągły’	540	380	400	270	398
‘Rywal’	540	470	430	340	445
Annual mean	506	465	477	251	425

For p = 0.05 (Tukey test), significant differences are marked with different letters

Table 5. Content of soluble sugars (% f.w.) in roots of 15 red beet cultivars in 2009-2012

Cultivar	2009	2010	2011	2012	Mean
‘Astar F_1’	7.61 de	7.92 ef	7.08 efg	7.31 bcde	7.48 BCD
‘Boro F_1’	6.44 ab	10.17 g	6.99 defg	7.89 def	7.87 CD
‘Ceryl’	8.61 g	8.37 f	8.77 h	8.74 f	8.62 D
‘Chrobry’	9.06 g	6.75 cd	7.75 g	7.95 ef	7.88 CD
‘Czerwona Kula’	6.54 ab	7.25 cde	7.07 efg	7.05 bcde	6.98 BC
‘Egipski’	7.35 de	8.34 f	7.57 fg	7.78 cde	7.76 CD
‘Karmazyn’	5.97 a	7.25 cde	5.91 b	6.44 b	6.39 AB
‘Nabab F_1’	7.33 d	5.04 a	3.19 a	5.15 a	5.18 A
‘Nochowski’	9.04 g	6.51 bc	6.88 def	7.44 cde	7.47 BC
‘Opolski’	8.40 f	6.41 bc	6.58 bcde	6.96 bcd	7.09 BC
‘Pablo F_1’	7.58 de	8.54 f	6.04 bc	7.18 bcde	7.34 BC
‘Patryk’	6.65 bc	8.07 ef	6.15 bcd	7.19 bcde	7.01 BC
‘Regulski Cylinder’	7.20 cd	7.39 de	6.77 cdef	7.76 cde	7.28 BC
‘Okrągły Regulski’	8.13 ef	5.87 ab	8.89 h	7.73 cde	7.65 CD
‘Rywal’	6.41 ab	7.95 ef	6.34 bcde	6.85 bc	6.89 BC
Annual mean	7.49 A	7.46 A	6.80 A	7.29 A	7.26

For p = 0.05 (Tukey test), significant differences are marked with different letters

Table 6. Content of betanin (mg g^{-1} f.w.) in roots of 15 red beet cultivars in 2009-2012

Cultivar	2009	2010	2011	2012	Mean
'Astar F_1'	0.62 de	0.64 b	1.36 gh	1.44 def	1.01 B
'Boro F_1'	0.52 bcd	0.82 f	1.07 cd	1.13 bc	0.89 AB
'Ceryl'	0.62 de	0.92 g	1.56 i	1.65 fg	1.19 B
'Chrobry'	0.86 g	0.70 c	1.1 de	1.22 bcd	0.97 AB
'Czerwona Kula'	0.47 b	0.81 ef	0.95 bc	1.06 b	0.82 AB
'Egipski'	0.28 a	0.39 a	0.63 a	0.77 a	0.52 A
'Karmazyn'	0.82 g	0.62 b	1.61 i	1.70 g	1.19 B
'Nabab F_1'	0.74 fg	0.76 de	1.18 ef	1.33 cde	1.00 B
'Nochowski'	0.78 g	0.91 g	1.45 h	1.56 efg	1.18 B
'Opolski'	0.59 cde	0.77 de	1.08 de	1.44 def	0.97 AB
'Pablo F_1'	0.62 de	0.59 b	1.08 de	1.17 bc	0.86 AB
'Patryk'	0.64 def	0.79 def	1.37 gh	1.19 bc	1.00 B
'Regulski Cylinder'	0.65 ef	0.75 cd	0.89 b	1.44 def	0.93 AB
'Okrągły Regulski'	0.59 cde	0.92 g	1.39 h	1.00 ab	0.98 AB
'Rywal'	0.50 bc	0.77 de	1.26 fg	1.35 cde	0.97 AB
Annual mean	0.62 A	0.74 A	1.2 B	1.3 B	0.97

For p = 0.05 (Tukey test), significant differences are marked with different letters

Table 7. Content of vulgaxanthin (mg g^{-1} f.w.) in roots of 15 red beet cultivars in 2009-2012

Cultivar	2009	2010	2011	2012	Mean
'Astar F_1'	0.17 abc	0.17 a	0.78 g	0.74 efg	0.47 AB
'Boro F_1'	0.17 abc	0.31 hi	0.68 def	0.63 de	0.45 AB
'Ceryl'	0.18 abc	0.26 fg	0.80 gh	0.73 efg	0.49 B
'Chrobry'	0.28 defg	0.22 cde	0.63 d	0.60 cd	0.43 AB
'Czerwona Kula'	0.19 abc	0.31 hi	0.44 bc	0.40 b	0.34 AB
'Egipski'	0.13 a	0.18 ab	0.18 a	0.18 a	0.17 A
'Karmazyn'	0.29 efg	0.21 bcd	0.87 h	0.79 fg	0.54 B
'Nabab F_1'	0.30 fg	0.36 k	0.76 fg	0.72 defg	0.53 B
'Nochowski'	0.25 cdefg	0.29 gh	0.74 efg	0.68 def	0.49 B
'Opolski'	0.25 cdefg	0.30 hi	0.65 de	0.84 g	0.51 B
'Pablo F_1'	0.22 bcdef	0.20 abc	0.65 de	0.59 cd	0.42 AB
'Patryk'	0.33 g	0.35 jk	0.39 b	0.63 de	0.42 AB
'Regulski Cylinder'	0.20 abcd	0.24 ef	0.40 b	0.35 b	0.30 AB
'Okrągły Regulski'	0.21 abcde	0.32 ij	0.88 h	0.39 b	0.45 AB
'Rywal'	0.15 ab	0.23 def	0.51 c	0.46 bc	0.34 AB
Annual mean	0.22 A	0.26 A	0.62 B	0.58 B	0.42

For p = 0.05 (Tukey test), significant differences are marked with different letters

Table 8. Ratio betanin/vulgaxanthin in roots of 15 red beet cultivars in 2009-2012

Cultivar	2009	2010	2011	2012	Mean
‘Astar F_1’	3.63	3.68	1.74	1.95	2.75
‘Boro F_1’	3.06	2.67	1.57	1.79	2.27
‘Ceryl’	3.43	3.57	1.95	2.26	2.80
‘Chrobry’	3.07	3.24	1.75	2.03	2.52
‘Czerwona Kula’	2.46	2.61	2.16	2.65	2.47
‘Egipski’	2.19	2.12	3.50	4.28	3.02
‘Karmazyn’	2.82	3.01	1.85	2.15	2.46
‘Nabab F_1’	2.48	2.12	1.55	1.85	2.00
‘Nochowski’	3.12	3.16	1.96	2.29	2.63
‘Opolski’	2.37	2.59	1.66	1.71	2.08
‘Pablo F_1’	2.81	2.95	1.66	1.98	2.35
‘Patryk’	1.93	2.26	3.51	1.89	2.40
‘Regulski Cylinder’	3.27	3.14	2.23	4.11	3.19
‘Regulski Okrągły’	2.83	2.87	1.58	2.56	2.46
‘Rywal’	3.32	3.29	2.47	2.93	3.00
Annual mean	2.85	2.89	2.08	2.43	2.56

For p = 0.05 (Tukey test), significant differences are marked with different letters

Table 9. Antioxidant activity (% of DPPH scavenging) in roots of 15 red beet cultivars in 2009-2012

Cultivar	2009	2010	2011	Mean
‘Astar F_1’	23.4 b	49.5 i	36.3 ef	36.4 GH
‘Boro F_1’	26.2 bcd	31.0 def	29.4 cde	28.9 CDEFG
‘Ceryl’	30.4 e	23.0 abc	31.8 de	28.4 CDEFG
‘Chrobry’	36.1 f	32.1 efg	32.6 de	33.6 FGH
‘Czerwona Kula’	25.9 bcd	16.5 a	27.5 bcd	23.3 ABCD
‘Egipski’	14.6 a	18.4 ab	17.8 a	16.9 A
‘Karmazyn’	31.4 e	24.2 bcd	28.6 bcde	28.1 BCDEFG
‘Nabab F_1’	28.7 de	34.2 fg	33.5 de	32.1 EFGH
‘Nochowski’	32.0 e	44.2 hi	43.4 f	39.9 H
‘Opolski’	24.0 bc	19.8 abc	21.6 abc	21.8 ABC
‘Pablo F_1’	15.8 a	35.3 fg	23.1 abc	24.7 ABCDE
‘Patryk’	28.0 cde	36.9 fg	33.2 de	32.7 EFGH
‘Regulski Cylinder’	25.6 bcd	38.1 gh	25.3 abcd	29.7 CDEFG
‘Okrągły Regulski’	30.5 e	25.7 cde	28.3 bcde	28.2 BCDEFG
‘Rywal’	23.9 bc	16.3 a	20.4 ab	20.2 AB
Annual mean	26.4 A	29.7 A	28.9 A	28.3

For p = 0.05 (Tukey test), significant differences are marked with different letters

A content of betalain pigments depends on the genetic predispositions and conditions during cultivation, especially on the weather conditions (Krężel 2005). In our experiment, due to the smallest amount of rainfall in 2012 the roots had the lowest mass, diameter, and content of dry weight; however, they contained the largest amount of betalain pigments (Table 6). Temperature is one of the most important features impacting the color of red beets. Hot, dry summers, and temperatures above 25 °C negatively affect the betalain pigments content (Magruder 1941; Lorenz 1947; Bradley & Dyck 1967) which is in agreement with the results of Nizioł-Łukaszewska and Gawęda (2014). High temperatures in the first three weeks of cultivation caused a drastic fall in the content of betacyanin and betaxanthin. In 2010, when the temperature was over 25 °C the very low levels of betalain pigments were recorded.

At present, well colored red beets with a high content of pigments are desired by farmers. According to Biegańska-Marecik et al. (2007), ‘Chrobry’ and ‘Nochowski’ meet that expectation. Study of Mikołajczyk and Czapski (2006) proved that the contents of red pigment were 220 mg·100 ml^{-1} and 187.2 mg·100 ml^{-1} in ‘Chrobry’ and ‘Nochowski’, respectively. In this study the content of red pigment in these cultivars was lower. The highest contents were recorded in ‘Ceryl’ and ‘Karmazyn’ although the significance between other cultivars was not stated. The exception was ‘Egipski’ in which the average content of betanin was 40% lower in comparison to the cultivars richest with this ingredient. Similar results were obtained by Sobkowska et al. (1991), who reported that ‘Egipski’ contained approximately half the amount of pigment as compared to other cultivars analysed and ‘Czerwona Kula’ even less. In our study, ‘Czerwona Kula’ contained more red pigments than ‘Egipski’.

The examination of the content of yellow pigments in red beets undertaken by Mikołajczyk and Czapski (2006) who demonstrated that the content of vulgaxanthin for ‘Chrobry’ was 125.7 mg·100 ml^{-1}, whereas for ‘Nochowski’ it was 80.2 mg·100 ml^{-1}. According to Elkner et al. (1997), the quantity of vulgaxanthin in ‘Chrobry’ was 84.5 mg·100 g^{-1} of juice. The results of our experiment indicated a lower content of vulgaxanthin in the listed cultivars, as the lowest average amount of vulgaxanthin was detected in ‘Egipski’, although it was not significantly different from the other nine cultivars (Table 7). Low content of pigments in ‘Egipski’ did not unfavorably influence the average betanin : vulgaxanthin ratio. A similar ratio of pigments in ‘Egipski’ was noticed by Sobkowska et al. (1991). This study found a high content of vulgaxanthin in ‘Karmazyn’ and ‘Nabab F$_1$’. Moreover, ‘Nabab F$_1$’ had the lowest betanin/vulgaxanthin ratio among the examined cultivars. The highest betanin/vulgaxanthin ratio was observed in ‘Regulski Cylinder’, ‘Rywal’ and ‘Egipski’ (Table 8).

In recent years, the interest in health-promoting compounds has increased greatly because of the high risk for lifestyle-related diseases. It concerns mainly the phenolic group present in betalaines, which is responsible for antioxidant properties of red beets (Grajek 2007). This study shows that ‘Egipski’ was characterized by the lowest antioxidant activity, and the highest ability for scavenging free radicals was found in ‘Nochowski’ although there were no significant differences with other four cultivars (Table 9). On the basis of the research conducted by Gębczyński (2005) it was stated that the antioxidant activity for ‘Czerwona Kula’ was 56.7%, nonetheless, in our experiment this capacity was about half as much and amounted to 23.36 %.

CONCLUSIONS

1. Red beet ‘Chrobry’ is characterized by the roots of a high quality and high contents of health-promoting compounds as dry matter, sugars and betalains and has a high antioxidant activity
2. Among cultivars of cylindrical shape of roots (‘Rywal’, ‘Opolski’, ‘Regulski Cylinder’), ‘Regulski Cylinder’ was characterized by the highest content of soluble sugars and also the highest antioxidant activity.

3. Antioxidant activity and also the content of betanin and vulgaxanthin was the lowest in cultivar 'Egipski', which was characterized by a large content of soluble sugars, high fresh weight and diameter as well as high betanin/vulgaxanthin ratio.

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