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CONTENTS OF CERTAIN CHEMICAL COMPONENTS IN SHALLOT BULBS AFTER HARVEST AND LONG-TERM STORAGE

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Abstract. Shallot is one of the vegetables, which are especially abounding in flavonoids, phenolic acids and other compounds with antioxidative properties. Among *Allium* vegetables it is also distinguished with good storage ability. The studies conducted in the years 2007–2009 included the assessment of dry matter, flavonoids and phenolic acid contents in shallot bulbs immediately after harvest and drying off, as well as after long-term storage (5 months in the temperature 0–1°C and humidity of 86%). The studies concerned 3 cultivars of shallot: 'Ambition F_1', 'Bonilla F_1' and 'Matador F_1'. The bulbs of these cultivars were obtained from seedlings planting. For chemical analyses bulb samples with the diameter of 25–30 mm were selected, as such constituted the greatest participation in the obtained yield. The contents of total and reducing sugars, flavonoids (converted into quercetin), as well as phenolic acids (converted into coffeic acid) were determined in fleshy scales, whereas in dry scales only the contents of flavonoids and phenolic acids were determined. The dry matter of fleshy scales in the examined shallot cultivars was on average 16.65%. From among three examined cultivars the bulbs of 'Bonilla F_1'had significantly greater dry matter (18.03% on average). The contents of total sugars in shallot bulbs was on average 6.32% immediately after harvest and 5.71% after 5 months of storage. Similarly as in the case of dry matter, the bulbs of 'Bonilla F_1' cultivar turned out to be the most abounding both in total and reducing sugars. The examined cultivars significantly differed in the contents of flavonoids and phenolic acids both in dry and fleshy scales. In all the cultivars the dry scales contained more than 50 times more flavonoids and more than 34 times more phenolic acids, as compared with fleshy scales. Long-term storage of shallot bulbs significantly affected the decrease of flavonoid contents, slight decrease of total sugars, but a significant increase of phenolic acids. From among the examined cultivars 'Ambition F_1' was characterized with the lowest contents of all the analyzed components.

Key words: *Allium cepa* L. var. *ascalonicum* Backer, cultivars, sugars, flavonoids, phenolic acids, storage

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INTRODUCTION

Shallot (*Allium cepa* L. var. *ascalonicum* Backer) is a vegetable abundant with biologically active compounds of antioxidant properties. These include, among others, flavonoids and phenolic acids [Arifin et al. 1999, Crozier et al. 2000, Horbowicz and Kotlińska 2001, Yang et al. 2004, Ly et al. 2005, Jiang 2006, Štajner et al. 2006, Stralil et al. 2006]. The basic nutrients in shallot, however, are sugars, the contents of which determines the sensory properties and may be a determinant of physiological maturity stage and post-harvest durability [Arifin et al. 1999, Okubo et al. 1999].

As compared to the common onion, shallot is distinguished by better storage ability. To a significant extent it is determined by high dry matter content, as well as close adherence of fleshy scales [Tendaj and Piusińska-Siedlecka 2002].

Important components of shallot bulbs are flavonols, which include, in. a. quercetin and kaempferol. In the studies conducted by Horbowicz and Kotlińska [2001] it was demonstrated that quercetin occurs only in the bulbs, whereas quercetin and kaempferol are present in leaves.

The contents of quercetin or its glycosides in shallot and or common onion bulbs may undergo a slow decrease, as the storage time goes by [Horbowicz and Kotlińska 2001, Lachman et al. 2003]. The content levels of flavonoids, as well as phenolic acids and sugars in shallot bulbs depend not only on plant maturity phase and the length of storage period, but also on the cultivar, as well as upon the post-harvest stabilization processes, i.e. drying and freezing [Lachman et al. 2003, Marinova et al. 2005, Horbowicz 2006].

The aim of the studies presented in this period was the evaluation of sugars, dry matter, flavonoids and phenolic acids contents in shallot bulbs immediately after harvest and after long-term storage. The study range included cultivars of shallot, propagated for cultivation in Poland.

MATERIAL AND METHODS

The studies were conducted in the years 2007–2009. The chemical analysis was performed of the shallot bulbs obtained from the experiment conducted in field conditions, in which the yielding of shallot was assessed, depending on cultivation method [Tendaj and Mysiak 2008]. To determine the dry matter, contents of total and reducing sugars, flavonoids and phenolic acids samples of 30 bulbs were collected from each cultivar (diameter 25–30 mm) obtained from planting seedlings. The above-mentioned components were determined in fleshy scales, whereas in dry scales only the contents of flavonoids and phenolic acids were determined. The following shallot cultivars, breeding by Bejo Zaden: 'Ambition F_1', 'Bonilla F_1' and 'Matador F_1' were included in the studies.

The chemical analyses were performed in two terms – after harvest and complete drying of the bulbs (October), as well as after 5. months of storing in a cold room (temperature 0–1^{o}C, relative humidity: 86%).

The dry matter was determined using dryer method (PN-90 A75101/03), the contents of sugars – by means of Luff-Schoorl method [Charłampowicz 1966], flavonoid

contents recalculated onto quercetin – using Christ-Müler method, described in Polish Pharmacopea V [Farmakopea Polska 1999], and the contents of phenolic acids recalculated onto coffeic acid were determined with the use of Arnov's spectrophotometric method, also described by Polish Pharmacopea V [Farmakopea Polska 1999].

The obtained results were statistically elaborated with the application of Tukey's test, with significance level of $p = 0.05$.

RESULTS AND DISCUSSION

Shallot, as compared to common onion, is distinguished by more dry matter and definitely higher contents of polyphenolic compounds, in. a. flavonoids and phenolic acids [Horbowicz 1999, Lachman et al. 2003, Yang et al. 2004, Jiang et al. 2006, Mysiak and Tendaj 2006]. Thus, this plant is one of the species with very high antioxidative activity [Leelarungrayub et al. 2006, Tangkanakul et al. 2009].

The studies presented in this work demonstrated that in shallot the contents of particular chemical compounds significantly depend upon the cultivar and term of performing the analyses (immediately after harvest or after 5 months of storage). Besides, the level of flavonoid and phenolic acid contents in dry scales is many times higher than the contents of these components in fleshy scales.

The dry matter of fleshy scales in the bulbs of the examined shallot cultivars equaled on average 16.65% and was on the similar level both immediately after harvest and drying off, as well as after 5 months of storing (tab. 1).

Table 1. Dry matter of shallot bulb fleshy scales after harvest and storage, %
Tabela 1. Sucha masa łusek mięsistych cebul szalotki po zbiorze i po 5 miesiącach przechowywania, %

Cultivar Odmiana	After harvest Po zbiorze			After storage Po przechowaniu			Mean Średnio
	2007	2008	mean średnio	2008	2009	mean średnio	
Ambition F_1	16.27	16.62	16.44	15.29	16.30	15.79	16.11
Bonilla F_1	17.68	18.81	18.24	18.03	17.63	17.83	18.03
Matador F_1	15.83	16.00	15.91	15.56	15.90	15.73	15.82
Mean – Średnio	16.59	17.14	16.86	16.29	16.61	16.45	16.65
$LSD_{0.05} – NIR_{0,05}$							
cultivar – odmiana							0.54
term of performing analysis – termin wykonana analizy							0.36
interaction – współdziałanie							n.s. ni.

Among the examined cultivars the bulbs of 'Bonilla F_1' were distinguished by significantly greater dry matter, as compared to the remaining cultivars (on average it was 18.03%). According to the studies conducted by Kotlińska [1995] the dry matter of shallots from various populations may equal 14,5 to 32%. What may significantly affect the level of dry matter contents in shallots, is harvest maturity phase. In the period of

full maturity, immediately after harvest, it can be, on average, 20% [Tendaj and Piusińska-Siedlecka 2005].

The mean content of total sugars in the bulbs of examined shallot cultivars was 6.32% after harvest and 5.71% after 5 months of storage, whereas the content of reducing sugars was, on average, 1.38% after harvest and 2.02% after storage.

Similarly as in the case of dry matter, the bulbs of 'Bonilla F_1'cultivar were distinguished by significantly the greatest contents of sugars. On the basis of cropping assessment of these cultivars in the cultivation from sowing directly into the field and from seedlings 'Ambition F_1' turned out to be the highest yielding, whereas 'Bonilla F_1' from seedlings had the weakest yield [Tendaj and Mysiak 2008]. This probes that the shallot bulb yield quantity does not depend directly upon the dry matter of of bulbs and the contents of sugars in them.

After 5 months of storage in the bulbs of certain cultivars the contents of total sugars significantly decreased and the contents of reducing sugars decreased significantly in all the cultivars (tab. 2). The contents of sugars in shallot bulbs, similarly to the common onion, may be different, depending on the cultivar, local growing conditions and post-harvest treatment. The previous studies by Tendaj and Piusińska-Siedlecka [2005], as well as by Jadczak and Wójcik-Stopczyńska [2007] demonstrated high variability of total and reducing sugar contents in shallot bulbs of local population, depending on weather conditions in subsequent years of growing.

In the shallot bulbs of the cultivars included in the studies described in this paper the contents of flavonoids converted into quercetin significantly depended upon the cultivar and term of performing the analysis of this component's content (after harvesting, drying and 5 months of storage). Studies by Horbowicz and Kotlińska [2001], Yang et al. [2004], Ly et al. [2005] and Štajner et al. [2006], demonstrated that the contents of flavonoids in shallot and other *Allium* vegetables depends on maturity stage, usable part of the plant, as well as on storage period. According to the studies of these authors, dry scales contain much more flavonoids than fleshy scales.

The examined cultivars significantly differed in the contents of flavonoids both in dry and fleshy scales. In the dry scales most of this component was found in 'Bonilla F_1' cultivar, whereas in fleshy scales – in 'Matador F_1'cultivar. Irrespective of the cultivar, flavonoid content in dry scales was more than 50 times higher than in fleshy scales and it concerned both the period immediately after harvest, and after 5 months of storage. The losses of flavonoid contents after 5 months of storage were not very large (on average 13.7%), but statistically they turned out to be significant (tab. 3). The studies by Horbowicz and Kotlińska [2001], as well as Horbowicz [2006] also demonstrated that during long-term storage the contents of quercetin in shallot bulbs slowly decreases. The contents of phenolic acids converted to coffeic acid was on average 2055.2 mg·100 g^{-1} in dry scales and 63.3 mg·100 g^{-1} in fleshy scales. The 'Matador F_1' cultivar was distinguished by significantly the greatest contents of these acids in dry scales, and the greatest in fleshy scales (tab. 4).

It was found that the phenolic acid contents after long-term storage significantly increases, on average by 9.3% in dry scales and by 8.7% in fleshy scales.

The studies by Yang et al. [2004], assessing in. al. the contents of polyphenolic compounds in various onion and shallot cultivars proved that shallot, as compared to

Table 2. Content of sugar in fleshy scales of shallot bulbs after harvest and storage, mg·100 g^{-1} f.m.
Tabela 2. Zawartość cukrów w łuskach mięsistych cebul szalotki po zbiorze i 5 miesiącach przechowywania, mg·100 g^{-1} św.m.

Cultivar Odmiana	Reducing sugars – Cukry redukujące						Mean Średnio	Total sugars – Cukry ogółem						Mean Średnio
	after harvest po zbiorze			after storage po przechowaniu				after harvest po zbiorze			after storage po przechowaniu			
	2007	2008	mean średnio	2008	2009	mean średnio		2007	2008	mean średnio	2008	2009	mean średnio	
Ambition F_1	1.51	1.39	1.45	1.58	2.48	2.03	1.74	5.45	6.09	5.77	3.46	5.68	4.57	5.17
Bonilla F_1	1.18	1.84	1.51	1.88	2.44	2.16	1.83	6.33	7.26	6.79	5.13	6.40	5.76	6.27
Matador F_1	0.97	1.42	1.19	1.64	2.10	1.87	1.53	5.39	7.44	6.41	4.06	5.90	4.98	5.69
Mean Średnio	1.22	1.55	1.38	1.70	2.34	2.02	1.70	5.72	6.93	6.32	4.21	5.99	5.10	5.71
$LSD_{0.05}$ – $NIR_{0,05}$														
cultivar – odmiana							0.080							0.469
term of performing analysis – termin wykonania analizy							0.053							n.s.. ni.
interaction – współdziałanie							0.290							0.820

Table 3. Contents of flavonoids (converted into quercetin) in dry and fleshy scales after harvest and storage, mg·100 g^{-1} f.m.
Tabela 3. Zawartość flawonoidów w łuskach suchych i mięsistych cebuli szalotki po zbiorze i po przechowywaniu, mg·100 g^{-1} św.m.

Cultivar Odmiana	Dry scales – Łuska sucha						Mean Średnio	Fleshy scales – Łuska mięsista						Mean Średnio
	after harvest po zbiorze			after storage po przechowaniu				after harvest po zbiorze			after storage po przechowaniu			
	2007	2008	mean średnio	2008	2009	mean średnio		2007	2008	mean średnio	2008	2009	mean średnio	
Ambition F_1	2168.7	1769.2	1968.9	1262.7	1146.1	1204.4	1586.6	44.0	25.9	34.9	36.0	21.5	28.7	31.8
Bonilla F_1	3355.3	1277.9	2316.6	3262.6	1027.7	2145.2	2230.9	42.7	34.8	38.7	35.7	31.2	33.5	36.1
Matador F_1	2456.6	1199.2	1827.9	2616.6	1245.4	1931.0	1879.4	47.3	32.6	39.9	45.3	26.7	36.0	38.0
Mean Średnio	2660.2	1415.4	2037.4	2380.6	1139.7	1760.2	1898.9	44.7	31.1	37.9	39.0	26.5	32.7	35.3
$LSD_{0.05}$ – $NIR_{0,05}$														
cultivar – odmiana							53.25							1.13
term of performing analysis – termin wykonania analizy							35.47							0.57
interaction – współdziałanie							94.89							2.01

Table 4. Content of phenolic acids (converted into caffeic acid) in dry and fleshy scales of shallot bulbs after harvest and storage, mg·100 g^{-1} f.m.
Tabela 4. Zawartość kwasów fenolowych w łuskach suchych i mięsistych cebuli szalotki po zbiorze i po przechowywaniu, mg·100 g^{-1} św.m.

Cultivar Odmiana	Dry scales – Łuska sucha						Mean Średnio	Fleshy scales – Łuska mięsista						Mean Średnio
	after harvest po zbiorze			after storage po przechowaniu				after harvest po zbiorze			after storage po przechowaniu			
	2007	2008	mean średnio	2008	2009	mean średnio		2007	2008	mean średnio	2008	2009	mean średnio	
Ambition F_1	1990.3	1212.2	1601.2	2568.0	1193.3	1880.6	1740.9	76.0	38.5	57.2	79.0	46.8	62.9	60.0
Bonilla F_1	2949.0	1325.5	2137.2	2694.3	1660.5	2177.4	2157.3	79.3	39.7	59.5	77.1	47.9	62.5	61.0
Matador F_1	2936.3	1368.1	2152.2	3004.0	1761.4	2382.7	22.67.4	75.7	40.6	58.1	82.0	47.5	64.7	61.4
Mean Średnio	2625.2	1301.9	1963.5	2755.3	1538.4	2146.9	2055.2	77.0	39.6	58.2	79.3	47.4	63.3	60.8
$LSD_{0.05}$ – $NIR_{0,05}$														
cultivar – odmiana							76.99							n.s. ni..
term of performing analysis – termin wykonania analizy							51.36							3.53
interaction – współdziałanie							137.18							n.s. ni.

common onion, in 10 American cultivars is distinguished with definitely greater contents of these compounds. Converted to gallic acid, the contents of these compounds was 114.7 ± 10 mg·100 g^{-1} f. w., whereas in the examined cultivars of common onion the contents of these compounds was between 16.8 and 104.9 mg·100 g^{-1} f. w. The previous studies performed by the authors of this paper [Tendaj and Mysiak 2008] demonstrated that the local populations of shallot, depending on growing season, may contain a lot of phenolic acids in dry scales (contents comparable to the data in this paper), or definitely less, whereas the fleshy scales of growing cultivar 'Creation F_1' contained significantly less phenolic acid, as compared to certain local populations. The studies by Ng et al. [2000] and Ly et al. [2005] indicate that the contents of phenolic acid in the dry scales of common onion is many times greater than the level of their contents in the fleshy scales. Thus, there is a certain convergence of the results obtained by us with the results concerning the contents of these acids, obtained in the studies by the authors mentioned above.

CONCLUSIONS

1. The examined cultivars of shallot significantly differed in dry matter, the contents of total and reducing sugars, as well as flavonoids and fenolic acids in the bulbs. The most abounding in these components turned out to be the bulbs of 'Bonilla F_1' and 'Matador F_1'cultivars. The bulbs of 'Ambition F_1' cultivar were characterized by the lowest dry weight and contained significantly less total sugars, flavonoids and phenolic acids.

2. Irrespectively of the cultivar, dry scales of shallot bulbs turned out to be extremely abounding in flavonoids and phenolic acids. They contained on average more than 34 times more phenolic acids and more than 54 times more flavonoids, as compared to fleshy scales.

3. Long-term storage of shallot bulbs (5 months) significantly affected the decrease of flavonoid contents, slight decrease of total sugar contents, but significant increase of phenolic acid contents. This concerned all the examined cultivars.

REFERENCES

Arifin N.S., Miyajina I., Okubo H., 1999. Variation of pigments in the bulbs of shallot (*Allium cepa* var. *ascalonicum*) and *Allium* x *wakeg*i. J. Fac. Agr. Kyushu Univ. 43 (3–4), 303–308.

Charłampowicz Z., 1966. Analizy przetworów z owoców, warzyw i grzybów. Wyd. Przem. Lekk. i Spoż., Warszawa.

Crozier A., Burns J., Aaziz A., Stewart A., Rabiasz H.S., Jenkins G., Edwards C.A., Lean M.E., 2000. Antioxidant flavonols from fruits, vegetables and beverages: measurements and bioavailability. Biol. Res. 33 (2), 96–114.

Farmakopea Polska [Polish Pharmacopoeia] V. 1999. Wyd. PTFarm Warszawa (In Polish).

Horbowicz M., 1999. Changes of the flavonols content in onion during the vegetation period and storage. Veg. Crops Res. Bull., 50, 81–91.

Horbowicz M., 2006. Wpływ przechowywania na zawartość kwercetyny w suszonej i mrożonej szalotce. Acta Agrobot. 59, 2, 175–182.

Horbowicz M., Kotlińska T., 2001. Changes of flavonols content during vegetation period and storage of shallot (*Allium cepa* var. *aggregatum*). Veg. Crops Res. Bull., 55, 81–90.

Jadczak D., Wójcik-Stopczyńska B., 2007. Influence of plant covering on some organic compound content and pungency of shallot grown for bunching harvest. Veg. Crops Res. Bull. 66, 25–30.

Jiang H., Ji B., Liang J., Zhou F., Yang Z., Zhang H., 2006. Comparison on the antioxidant capacity of selected fruits and vegetables and their separations. Chem. Natur. Compoun. 42, 4, 410–414.

Kotlińska T., 1995. Zróżnicowanie cech użytkowych populacji szalotki (*A. cepa* var. *aggregatum*). Mater. Konf. V Ogólnopol. Zjazdu Hod. Rośl. Ogrod. Skierniewice, 23–24 lutego 1995, 148–155.

Lachman J., Proněk D., Hejtmánková A., Dudjak J., Pivec V., Faitová K., 2003. Total polyphenol and main flavonoid antioxidants in different onion (*Allium cepa* L.) varietes. Hort. Sci. (Prage), 30, 4, 142–147.

Leelarungrayub N., Rattanapanone V., Chanart N., Gebicki J.M., 2006. Quantitative evaluation of antioxidant properties of garlic and shallot preparations. Nutrition. 22, 266–274.

Ly T.N., Hazama C., Shimoyamada M., Ando H., Kato K., Yamauch R., 2005. Antioxidative compounds from the outer scales of onion. J. Agric. Food Chem. 53, 8183–8189.

Marinova D., Ribarova F., Atanassova M., 2005. Total phenolics and total flavonoids in Bulgarian fruits and vegetables. J. Univ. Chem. Technol. Metallurg. 40, 3, 255–260.

Mysiak B., Tendaj M., 2006. Content of flavonoids in some *Allium* species grown for green bunching. Veg. Crop Res. Bull. 65,105–110.

Ng A., Parker M.L., Parr A.J., 2000. Physicochemical characteristics of onion (*Allium cepa* L.) tissues. J. Agric. Food Chem. 48, 5612–5617.

Okubo H., Afrin N.S., Noriko M., 1999. Bulbing response of shallot (*Allium cepa* L. var. *ascalonicum* Backer) and *Allium* × *wakegi* Araki to daylength and temperature. 68 (2), 283–285.

Stratil P., Kleidus B., Kubán V., 2006. Determination of total content of phenolic compounds and their anioxidant activity in vegetables – evaluation of spectrophotometric methods. J. Agric. Food Chem. 54, 607–616.

Štajner D., Milić N., Čanadanović-Bruntel J., Kapor A., Štajner M., Popović M., 2006. Exploring *Allium* species as a source of potential medicinal agents. Phytother. Res. 20, 581–584.

Tangkanakul P., Auttaviboonkul P., Niyomwit B., Lowvitoon N., Charoenthamawat P., Trakoontivakorn G., 2009. Antioxidant capacity, total phonolic content and nutritional composition of Asian foods after thermal processing. I. Food Res. J., 16, 571–580.

Tendaj M., Mysiak B., 2008. Plon i jakość cebul szalotki uprawianej z siewu i rozsady. Now. Warz. 47, 25–31.

Tendaj M., Piusińska-Siedlecka M., 2002. The effect of growing methods on storage losses of shallot bulbs. *Allium* Improv. Newslet. 12, 12–14.

Tendaj M., Piusińska-Siedlecka M., 2005.. Wpływ fazy dojrzałości zbiorczej na jakość plonu cebul szalotki (*Allium cepa* L. var. *ascalonicum* Backer). Annales UMCS, Sec. EEE, Horticultura, 15, 65–72.

Yang J., Meyers K.J. Heide J., Liu R.H., 2004. Varietal differences in phenolic content and antioxidant and antiproliferative activities of onion. J. Agric. Food Chem. 52, 6787–6793.

ZAWARTOŚĆ NIEKTÓRYCH SKŁADNIKÓW CHEMICZNYCH W CEBULACH SZALOTKI PO ZBIORZE I DŁUGOTRWAŁYM PRZECHOWYWANIU

Streszczenie. Szalotka należy do warzyw szczególnie zasobnych we flawonoidy, kwasy fenolowe i inne związki o właściwościach antyoksydacyjnych. Spośród warzyw cebulowych wyróżnia się także dobrą trwałością przechowalniczą. Badania przeprowadzone w latach 2007–2009 obejmowały ocenę zawartości suchej masy, flawonoidów i kwasów fenolowych w cebulach szalotki tuż po zbiorze i dosuszeniu oraz po długotrwałym przechowywaniu (5 miesięcy w temperaturze 0–1°C i wilgotności 86%). W badaniach uwzględniono 3 odmiany szalotki: 'Ambition F_1', 'Bonilla F_1' i 'Matador F_1'. Cebule tych odmian uzyskano z sadzenia rozsady. Do analiz chemicznych wybrano próby cebul o średnicy 25–30 mm, gdyż takie stanowiły największy udział w uzyskanym plonie. Zawartość cukrów ogółem i redukujących, flawonoidów (w przeliczeniu na kwercetynę) oraz kwasów fenolowych (w przeliczeniu na kwas kawowy) oznaczono w łuskach mięsistych, natomiast w łuskach suchych tylko zawartość flawonoidów i kwasów fenolowych. Sucha masa łusek mięsistych u badanych odmian szalotki wynosiła średnio 16.65%. Spośród trzech badanych odmian istotnie większą suchą masą wyróżniały się cebule odmiany 'Bonilla F_1' (średnio 18,03%). Zawartość cukrów ogółem w cebulach szalotki wynosiła średnio 6,32% tuż po zbiorze i 5,71% po 5 miesiącach przechowywania. Podobnie jak w przypadku suchej masy, cebule odmiany 'Bonilla F_1' okazały się najbardziej zasobne zarówno w cukry ogółem, jak i redukujące. Badane odmiany różniły się istotnie zawartością flawonoidów i kwasów fenolowych zarówno w łuskach suchych, jak i mięsistych. U wszystkich odmian łuska sucha zawierała ponad 50 razy więcej flawonoidów i ponad 34 razy więcej kwasów fenolowych, w porównaniu z łuską mięsistą. Długotrwałe przechowywanie cebul szalotki wpłynęło istotnie na zmniejszenie zawartości flawonoidów, nieznaczne zmniejszenie cukrów ogółem, lecz istotne zwiększenie zawartości kwasów fenolowych. Spośród badanych odmian 'Ambition F_1' charakteryzowała się najmniejszą zawartością wszystkich analizowanych składników.

Słowa kluczowe: *Allium cepa* var. *ascalonicum* Backer, odmiany, cukry, flawonoidy, fenolokwasy, przechowywanie

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