SACCHARIDE CONTENT IN POTATO TUBERS TREATED WITH BIOSTIMULATORS

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Abstract. Field research was carried out in 2015-2017 on an individual farm in Międzyrzec Podlaski (51°59' N and 22°47' E) in Poland. The aim of the study was to determine the effect of the type of biostimulators used (Kelpak SL, Titanit, GreenOk, BrunatneBio Złoto Cytokininy) on the saccharides content in tubers of three edible potato varieties (Honorata, Jelly, Tajfun). Potato plants were treated three times with biostimulators (starting from the BBCH 39 phase, every 10-14 days) with the potato plants sprayed with distilled water as the control object. The experiment was based on the split-plot method. A large amount of precipitation –325.4 mm and the lowest average air temperature –14.6 °C in 2017 contributed to the increase in the content of reducing sugars in potato tubers. Tubers of plants treated with the GreenOk preparation were characterized by the highest total sugar content compared to plants from the control object. The content of saccharides in tubers was significantly differentiated by the genotype of the variety. The largest amount of sugars was collected by the Honorata variety, and the least of the Tajfun variety.
Keywords: *Solanum tuberosum L., varieties, total sugars, reducing sugars, sucrose, types of bioregulators*

Introduction

One of the important characteristics of potato (*Solanum tuberosum* L.) determining the suitability of varieties for direct consumption and for processing is the content of reducing sugars, called monosaccharides (glucose + fructose) and the sums of sugars, or the total sugar (reducing sugars + sucrose). The content of reducing sugars in potato tubers is about 0.3%, and the total sugar to 1.0% in fresh tuber mass. Higher concentration of monosaccharides increases the intensity of Maillard reactions (Copp et al., 2000; Edwards et al., 2002), and causes darkening of the pulp during thermal processing (such as frying and drying) and deterioration of taste and smell, and in the final frying phase the formation of acrylamides (Hebeisen et al., 2005; Saraiva and Rodrigues, 2011; Shepherd et al., 2010). Aspargins and acrylamides derived from reducing sugars are dangerous to health and have been classified by the World Health Organization (WHO) as carcinogens for humans and animals (Keijbets, 2006; Tajner-Czopek, 2011). The use of raw material with low (0.1–0.2%) concentration of reducing sugars is considered the basic factor inhibiting the formation of acrylamide (Biedermann-Brem et al., 2003; De Wilde et al., 2006). In limiting the amount of acrylamide formed it may be helpful to soak and blanch French fried before frying, which reduces the content of reducing sugars in the fries (Pedreschi et al., 2007). The high sugar content (above 1% in fresh mass) decreases the taste properties, as tubers become sweetish and darken the pulp (Boguszewska, 2007; Kraska, 2002; Leszczyński, 2000; Zgórska et al., 2006a). Biostimulators control mineral metabolism, increase plant resistance to stressful environmental conditions (Sawicka and Mikos-Bielak, 2002; Wierzbowska et al., 2015), affect chemical composition, as well as increase resistance to attacks from diseases and pests (Grzyś, 2012). The content of reducing sugars and

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sucrose in the potato is influenced by the genetic factor, types of biostimulators and weather conditions.

Due to the few studies on the beneficial effects of biostimulators on the content of sugars, reducing sugars and sucrose, studies were undertaken to determine the effect of biostimulators (Kelpak SL, Titanit, GreenOk, BrunatneBio Złoto Cytokininy) on the saccharides content in tubers of three edible potato varieties (Honorata, Jelly, Tajfun).

Materials and methods

The experimental site

The potato tubers from a three-year field experiment carried out in 2015-2017 on an individual farm in Międzyrzec Podlaski (51°59' N i 22°47' E), Biała Podlaska county, Lublin voivodeship, in Poland were the material for studies. The experiment was established in three replications using the split-plot method, on the soil included in the very good rye complex, class IVa.

In individual years of research, soils differed in the content of organic matter and absorbable macro-elements. In 2015 and 2016, the soil was characterized by slightly acidic reaction, and in the last year of research, alkaline. The content of organic matter ranged from 15.0 to 18.7 $g \cdot kg^{-1}$. The content of absorbable phosphorus (P) was from high to very high, potassium (K) from medium to very high, and magnesium (Mg) was high. The first factor were three moderately early varieties of edible potato: Honorata, Jelly and Tajfun, and the second one, four types of biostimulators used in three dates (beginning of flowering, fully flowering and after flowering of plants):

1. Control object – without the use of biostimulators spraying with distilled water
2. Biostimulator Kelpak®SL (active substance - *Ecklonia maxima* algae extract), containing plant hormones: auxin – 11 $mg \cdot l^{-1}$ and cytokinin – 0.031 $mg \cdot l^{-1}$, at a dose of 0.20 $l \cdot ha^{-1}$
3. Biostimulator Tytanit® (active substance – titanium) at a dose of 0.20 $l \cdot ha^{-1}$,
4. Biostimulator GreenOk® (active substance – humus substances 20 $g \cdot l^{-1}$) at a dose of 0.20 $l \cdot ha^{-1}$
5. Biostimulator BrunatneBio Złoto (active substances – plant hormones: auxin – 0.06 $mg \cdot l^{-1}$ and cytokinin – 12 $mg \cdot l^{-1}$) at a dose of 0.20 $l \cdot ha^{-1}$

The forecrop for potato in particular years of research was winter wheat. After harvesting the forecrop, a team of post-harvest crops was made. In autumn, each year preceding planting, natural fertilization in the form of manure in the amount of 25.0 $t \cdot ha^{-1}$ and mineral fertilization with phosphorus-potassium in the amount of P – 44.0 (100 $P_2O_5 \cdot 0.44$) $kg \cdot ha^{-1}$ (lubofos for potatoes 7%) and K – 124.5 (150 $K_2O \cdot 0.83$) $kg \cdot ha^{-1}$ (lubofos for potatoes 25%) was applied. These fertilizers were plowed pre-season plowing. Nitrogen fertilizers were sown in the spring in an amount of N 100 kg/ha (nitro-chalk 27%) and mixed with the soil using a cultivator. Potatoes were planted manually under the marker at a spacing of 67.5 × 37 cm, in the third decade of April (24 April 2015, 30 April 2016, 22 April 2017). Each plot consisted of five ridges. Cultivation and care treatments were carried out in accordance with the requirements of correct agrotechnics and methodological assumptions of the experiment. During the growing season, observations of the most important phases of potato development were carried out on each object: emergence, flowering buds, flowering, maturation of plants. Potato plants were treated three times with biostimulators (starting from the BBCH 39

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phase, every 10-14 days) with the potato plants sprayed with distilled water as the control object. Prior to harvest, random samples of tubers were collected from ten potato plants (excluding the marginal crops) each plot and used for chemical analysis and assessment of consumption-related characteristics of the tubers. The harvest was made during the technological maturity of tubers, in the first decade of September (02 September 2015, 03 September 2016, 05 September 2017).

Chemical analysis methods

For the tests, 5 kg of potato samples were taken from each variety and combination. The tubers were homogenized by in-depth mixing of the pulp and samples were taken for laboratory determinations for the content of reducing sugars and total. The content of reducing sugars and total sugar was determined in fresh weight of unpeeled tubers with the Luff-Schoorl method. This method is based on the reduction reaction in the alkaline medium at the boiling temperature of the copper salts in the Luff solution by the reducing sugars contained in the solution (Krełowska-Kułas, 1993). The sucrose content was calculated from the difference of the total sugar after hydrolysis and reducing sugars × 0.95.

Meteorological conditions

The weather conditions in the potato growing years were shown by means of precipitation sums and average air temperatures in *Table 1*. The growing season of 2015 had the average air temperature of 15.2 °C, higher by 0.2 °C than the long-term mean and rainfall at 295.1 mm, but unevenly distributed throughout the growing season. The highest average air temperature was recorded in 2016 and amounted to 15.8 °C, it was higher than the long-term average by 0.8 °C, while this year was characterized by the lowest amount of precipitation – 200.9 mm, lower by 134.5 mm from the long-term sum, was one of the least favourable years, with a high rainfall deficit in the period of June-August, decisive for yield accumulation. The highest number of rainfall was recorded in the growing season 2017 –325.4 mm and the lowest average air temperature –14.6 °C (*Table 1*).

Table 1. *Air temperature and rainfall potato growing seasons according*

Months	Air temperature (°C)				Rainfall (mm)			
	Multi-year mean	Monthly means			Multi-year mean	Monthly sums		
	1996-2010	2015	2016	2017	1996-2010	2015	2016	2017
April	8.0	8.2	9.1	6.9	33.6	30.0	28.7	59.6
May	13.5	12.3	15.1	13.9	58.3	100.2	54.8	49.5
June	17.0	16.5	18.4	17.8	59.6	43.3	36.9	57.9
July	19.7	18.7	19.1	16.9	57.5	62.6	35.2	23.6
August	18.5	21.0	18.0	18.4	59.9	11.9	31.7	54.7
September	13.5	14.5	14.9	13.9	42.3	47.1	13.6	80.1
April–September	15.0	15.2	15.8	14.6	335.4	295.1	200.9	335.4

Statistical analysis

Results of the study were analysed by ANOVA. Significance of sources of variation was checked with the Fisher-Snedecor test and the significance of differences between

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means was tested using the multiple comparison Tukey's test at the significance level of P = 0.05. Statistical calculations were performed in Excel using the authors' own algorithm based on the split-plot mathematical model.

Results and discussion

Based on a three-year study, the level of total sugars, reducing sugars and sucrose was determined in three varieties of edible potato tubers, and it was up to 1% in the fresh weight of tubers. These results were confirmed by the studies of Zgórska et al. (2006a). Chemical analyses have shown, and statistical calculations have confirmed the significant impact of varieties, types of biostimulators, as well as weather conditions in the years of research on the saccharides content in potato tubers. In own studies, the average content of total sugars in edible potato tubers was 6.72 $g \cdot kg^{-1}$, reducing sugars 3.25 $g \cdot kg^{-1}$, sucrose 3.30 $g \cdot kg^{-1}$ (*Tables 2*, *3* and *4*). The research presented shows that the genetic factor had an effect on the sum of sugars, reducing sugars and sucrose in potato tubers. The variety that contained the most sugars in total was Honorata, then Jelly and Tajfun. The varieties compared were different in terms of the accumulation of the component in question. The highest amount of sugars was accumulated by the Honorata variety – on average 6.94 $g \cdot kg^{-1}$, Jelly – on average 6.70 $g \cdot kg^{-1}$, and the least by Tajfun – on average 6.54 $g \cdot kg^{-1}$. Among the tested varieties, the most reducing sugars in tubers was accumulated by the Tajfun variety, significantly lower content was found in Jelly tubers, while the smallest amounts were found in the tubers of the Honorata variety. In reference to sucrose, it was found that significantly most of this saccharide was found in tubers of the Honorata variety, and significantly least was found in the tubers of the Tajfun variety. In this study, varietal differences in the content of reducing sugars and sucrose in potato tubers have been demonstrated, which was the subject of research by Grudzińska and Zgórska (2008). These results were confirmed by Gugała et al. (2013), Sawicka and Pszczółkowski (2005). According to these authors, the content of reducing sugars and sucrose is a feature directly related to the genotype of a given variety. Grudzińska et al. (2016), Zgórska and Grudzińska (2012) showed a significant effect of the genetic factor on the content of reducing sugars in edible potato tubers. It was observed that the biostimulators had a significant influence on the content of reducing sugars. Under the influence of biostimulators used, there was a slight increase in the saccharides content compared to tubers from the control object – on average from 0.4 to 1.3%. Tubers of plants treated with the GreenOk preparation were characterized by the highest content of sugars - 6.78 $g \cdot kg^{-1}$, in comparison to plants from the control object, while reducing sugars from 2.71 $g \cdot kg^{-1}$ to 3.51 $g \cdot kg^{-1}$, respectively. With regard to sucrose, the minimum content was from 3.2 $g \cdot kg^{-1}$ on the object, where Kelpak SL was used, and the largest on the object where the BrunatneBio Złoto biostimulator 3.5 $g \cdot kg^{-1}$ was used. However, not all biostimulators have been statistically proven. In studies by Czeczko and Mikos-Bielak (2004), the Asahi SL biostimulator used increased the concentration of sucrose, but these changes have not been statistically proven. The random factor, i.e. the conditions prevailing in the years of research, resulted in the diversification of the sum of sugars in potato tubers. The highest content of total sugars and sucrose was determined by tubers harvested in 2015 and 2016, which were characterized by high air temperature of 15.2 °C and 15.8 °C and precipitation of 295.1 mm, and the lowest total sugars and sucrose level was accumulated by tubers harvested in 2017, which was distinguished by favourable weather conditions during the

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growing season (*Table 1*). Grudzińska (2012) also confirmed the significant impact of weather conditions on the level of total sugars in edible potato tubers. The highest content of reducing sugars 3.46 $g \cdot kg^{-1}$ was characteristic of tubers harvested in `hich was characterized by the highest rainfall and the lowest average air temperature – 14.6 °C and longer vegetation period. The prolongation of the growing season resulted in the accumulation if simple sugars, but in a quantity not lowering the technological value of potato tubers. Variable atmospheric conditions in the years of conducting the experiment resulted in significant interactions: years × variety, years × types of biostimulators and years × varieties × types of biostimulators. The proven interaction between the studied factors documents the varied response of cultivated varieties and their combination with plant growth biostimulators. Mazurczyk and Lis (2001) and Zgórska and Frydecka-Mazurczyk (2002) found that high temperature and low soil moisture limited the accumulation of sugars regardless of the variety. In contrast, Antonious et al. (2001) found the effect of weather on the concentration of reducing sugars. The prolongation of the growing season resulted in the accumulation of simple sugars but in the amount not lowering the technological value of potato tubers. The highest content of sucrose was characterized by tubers harvested in the growing season with low temperature at harvest time and with a lot of rainfall. Such climatic conditions could have caused secondary tuber growth and subsequent maturation. At high temperatures and a very small sum of precipitation, all tested varieties were characterized by the lowest content of

Table 2. *Content of total sugars in potato tubers, $g \cdot kg^{-1}$ fresh matter*

Objects	Cultivars			Years			Mean
	Honorata	Jelly	Tajfun	2015	2016	2017	
1. Control object	6.93	6.50	6.52	6.59	6.82	6.54	6.65
2. Kelpak SL	6.98	6.60	6.49	6.77	6.77	6.54	6.69
3. Tytanit	6.93	6.75	6.47	6.89	6.76	6.50	6.72
4. GreenOk	6.92	6.79	6.63	6.89	6.90	6.56	6.78
5. BrunatneBio Złoto	6.93	6.80	6.57	6.96	6.83	6.52	6.77
Mean	6.94	6.70	6.54	6.82	6.82	6.53	-

$LSD_{0,05}$ for: cultivars – 0.014; objects – 0.022; years – 0.014; interaction: objects × years – 0.038; cultivars × years – 0.024; cultivars × objects – 0.032; cultivars × objects × years – 0.056

Table 3. *Content of reducing sugars in potato tubers, $g \cdot kg^{-1}$ fresh matter*

Objects	Cultivars			Years			Mean
	Honorata	Jelly	Tajfun	2015	2016	2017	
1. Control object	3.06	3.48	3.48	3.40	3.16	3.46	3.34
2. Kelpak SL	3.07	3.38	3.51	3.23	3.22	3.45	3.32
3. Tytanit	3.07	3.25	3.48	3.10	3.24	3.50	3.28
4. GreenOk	3.08	3.21	3.35	3.11	3.09	3.43	3.21
5. BrunatneBio Złoto	2.71	3.19	3.42	3.03	2.81	3.48	3.11
Mean	3.00	3.30	3.45	3.17	3.10	3.46	-

$LSD_{0,05}$ for: cultivars – 0.157; objects – 0.211; years – 0.157; interaction: objects × years – 0.366; cultivars × years – 0.272; cultivars × objects – 0.312; cultivars × objects × years – 0.541

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Table 4. *Content of sacharose in potato tubers, g·kg^{-1} fresh matter*

Objects	Cultivars			Years			Mean
	Honorata	Jelly	Tajfun	2015	2016	2017	
1. Control object	3.67	2.87	2.80	3.03	3.47	2.90	3.14
2. Kelpak SL	3.71	3.05	2.80	3.36	3.37	2.90	3.20
3. Tytanit	3.67	3.30	2.84	3.60	3.34	2.85	3.30
4. GreenOk	3.65	3.40	3.12	3.60	3.62	2.90	3.40
5. BrunatneBio Złoto	4.00	3.40	2.99	3.70	3.82	2.88	3.50
Mean	3.70	3.20	2.90	3.65	3.50	2.90	-

$LSD_{0,05}$ for: cultivars – 0.151; objects – 0.211; years – 0.151; interaction: objects × years – 0.344; cultivars × years – 0.252; cultivars × objects – 0.332; cultivars × objects × years – 0.521

Conclusions

Under the influence of the biostimulators used, there was a slight increase in the total sugar content and sucrose, a reduction in reducing sugars compared to tubers from the control object. Tubers of plants treated with the BrunatneBio Złoto Cytokiny preparation were characterized by the highest content of sucrose and the smallest content of reducing sugars. While tubers of plants treated with the GreenOk biostimulator were characterized by the highest content of total sugars, in comparison to plants from the control object.

REFERENCES

[1] Antonious, G. F., Lee, C. M., Snyde, J. C. (2001): Sustainable soil management practices and quality of potato grown on erodible lands. – J. Envir. Sci. Health B., 36(4): 435-444.

[2] Biedermann-Brem S., Noti A., Grab K. (2003): How much reducing sugar may potatoes contain to avoid excessive acrylamide formation during roasting and baking? – Eur. Food Res. Technol. 217: 369-373.

[3] Boguszewska, D. (2007): The effect of water deficiency on the content of selected chemical components in potato tubers. – Żywność. Nauka. Technologia. Jakość 5(54): 93-101 (in Polish).

[4] Copp, L. J., Blenkinsop, R. W., Yada, R. Y., Marangoni, A. G. (2000): The relationship between respiration and chip color during long-term storage of potato tubers. – Am. J. Potato Res. 77: 279-287.

[5] Czeczko, R., Mikos-Bielak, M. (2004): The effects of using the Asahi biostimulator in the cultivation of various types of vegetables. – Annales UMCS, s. E: Agricultura 59(3): 1073-1079.

[6] De Wilde, T., Meulenaer, B., Mestdagh, F., Govaert, Y., Ooghe, W., Fraselle, S. (2006): Selection criteria for potato tubers to minimize acrylamide formation during frying. – J. Agric. Food Chem. 54(6): 2199-2205.

[7] Edwards, Ch. G., Englar, J. W., Brown Ch. R., Peterson, J. C., Sorensen, E. J. (2002): Changes in color and sugar content of yellow-fleshed potatoes stored at three different temperatures. – Am. Potato Res. 79: 49-53.

[8] Grudzińska, M. (2012): The influence of atmospheric and storage conditions on technological characteristics of potato in the production of French fries and crisps. – Biul. IHAR 265: 137-148.

[9] Grudzińska, M., Zgórska, K. (2008): Influence of sugars content in potato tubers on the color of crisps. – Żywność. Nauka. Technologia. Jakość 5(60): 107-115.

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DOI: http://dx.doi.org/10.15666/aeer/1702_27912797

[10] Grudzińska, M., Czerko, Z., Wierzbicka, A., Borowska-Komenda, M. (2016): Changes of reduction success and sacharose content in tubers of 11 potato cultivars while storing at 5 and 8 °C temperature. – Acta Agroph. 23(1): 31−38.
[11] Grzyś, E. (2012): The Effect of Selected Biologically Active Substances on Maize Cultivated under Stress Conditions. – Monografie CXLV. Wyd. UP, Wrocław (in Polish).
[12] Gugała, M., Zarzecka, K., Sikorska, A., Dołęga, H. (2013): Change in the content of sugars in potato tuber varieties depending on the method of weeding. – Prog. Plant Prot./Post. Ochr. Roślin 53(2): 271-275.
[13] Hebeisen, T., Ballmer, T., Guthapfel, N., Torche, J. M., Reust, W. (2005): Suitable potato varieties reduce acrylamide formation in processed products and disher. – 16th Triennial Conference of the European Association for Potato Research, July 17–22, Bilbao, Spain, pp. 496-500.
[14] Keijbets, M. J. H. (2006): Adding Value to Potatoes by Processing for the Benefits of the Consumer. – In: Havenkort, A. J., Struik, P. C. (eds.) Potato in Progress. Science Meets Practice. Academic Publishers, Wageningen, pp. 33-38.
[15] Kraska, P. (2002): Influence of cultivation methods, fertilization levels and protection on selected potato quality traits. – Zesz. Probl. Post. Nauk Rol. 489: 229-237.
[16] Krełowska-Kułas, M. (1993): Research on the Quality of Food Products. – Państwowe Wyd. Ekonomiczne, Warszawa, pp. 53-55 (in Polish).
[17] Leszczyński, W. (2000): Quality of consumer potato. – Żywność. Nauka. Technologia. Jakość 4(25): 5−27.
[18] Mazurczyk, W., Lis, B. (2001): Variation of chemical composition of tubers of potato table cultivars grown under deficit and excess of water. – Pol. J. Food Nutr. Sci. 10(51): 27-30.
[19] Pedreschi, F., Kaack, K., Granby, K., Troncoso, E. (2007): Acrylamide reduction under different pre-treatments in French fries. – J. Food Engin. 79: 1287-1294.
[20] Saraiva, J. A., Rodrigues, I. M. (2011): Inhibition of potato tuber sprouting by pressure treatments. – Int. J. Food Sci. Technol. 46: 61-66.
[21] Sawicka, B., Mikos-Bielak, M. (2008): Modification of Potato Tuber Chemical Composition by Applications of the Asahi SL Biostymulator. – In: Dąbrowski, Z. T. (ed.) Biostimulators in Modern Agriculture. Solanaceous crops. Editorial House Wieś Jutra, Warszawa, pp. 61-67.
[22] Sawicka, B., Pszczółkowski, P. (2005): Dry matter and carbohydrates content in the tubers of very early potato varieties cultivated under coverage. – Acta Sci. Pol., Hortorum Cultus 4(2): 111-122.
[23] Shepherd, L. V. T., Bradshaw, J. E., Dale, M. F. B., McNicol, J. W., Pont, S. D. A., Mottram, D. S., Davies, H. V. (2010): Variation in acrylamide producing potential inpotato: Segregation of the trait in a breeding population. – Food Chemistry 123: 568-573.
[24] Tajner-Czopek, A. (2011): The Impact of Technological Treatments on the Properties of Potato Fries and Acrylamide Content. – Wyd. Uniwersytetu Przyrodniczego, Wrocław.
[25] Wierzbowska, J., Cwalina-Ambroziak, B., Głosek, M., Sienkiewicz, S. (2015): Effect of biostimulators on yield and selected chemical properties of potato tubers. – J. Elem. 20(3): 757-768.
[26] Zgórska, K., Frydecka-Mazurczyk, A. (2002): Arrangement of dry matter and saccharides in various parts of potato tubers. – Zesz. Probl. Post. Nauk Rol. 489: 327-334.
[27] Zgórska, K., Grudzińska, M. (2012): Changes in selected quality traits of potato tubers during storage. – Acta Agroph. 19(1): 203-214.
[28] Zgórska, K., Czerko, Z., Grudzińska, M. (2006 a): The influence of storage conditions on some culinary and technological characteristics of tubers of selected potato varieties Zesz. – Probl. Post. Nauk Rol. 511: 567-578.

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