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WINTER SQUASH (*CUCURBITA MOSCHATA* DUCH) FRUIT AS A SOURCE OF BIOLOGICALLY ACTIVE COMPONENTS AFTER ITS THERMAL TREATMENT

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ABSTRACT
To one of the most valuable pumpkin fruit belongs winter squash (*Cucurbita moschata* Duch). The aim of this work was to assess the quality of *C. moschata* fruit and to assess the dynamics of compositional changes after the heat treatment of the pulp. We used six varieties Liscia, Orange, Hannah, UG 201 F1, Waltham, Serpentine. In the samples were analyzed carbohydrate content (glucose, fructose and sucrose), total polyphenols, total carotenoids and antioxidant activity. The fresh pulp and pulp after the heat treatment were observed. Content of carbohydrates was determined by FTIR infrared spectroscopy. Content of total carotenoids, polyphenols and antioxidant activity was determined by spectrophotometry. As the dominant sugar was found to be sucrose. The lowest content of all carbohydrates was found in the variety Serpentine. Fructose content ranged from 7.59 to 12.32 g.100 g^{-1} dry matter, glucose content from 7.23 to 9.79 g.100 g^{-1} dry matter and sucrose content 38.67 to 55.94 g.100 g^{-1} dry matter. After processing there was found a decrease in the sucrose and the slight increase in glucose and fructose content. Total carotenoid content in fruits ranged from 39.01 to 97.67 g mg.100 g^{-1} dry matter, the content of total polyphenols from 443.98 to 565.44 mg GAE.100 g^{-1} dry matter and antioxidant activity from 680.18 to 851.87 mg AA.100 g^{-1} dry matter. After the heat treatment, there was found some decrease in total carotenoids, polyphenols and antioxidant activity as well.

Keywords: winter squash; total carotenoid; total polyphenols; antioxidant activity

INTRODUCTION
Recently, it is increasing interest about the use of less known vegetable species as potential sources of raw materials and biologically active substances for agricultural, pharmaceutical and food applications. New sources of agricultural raw materials are the subject of research, which would positively affect nutritional trends and reduce the frequency of lifestyle disease occurrence. Such vegetables include *Cucurbita moschata Duch* **(Kim et al., 2012)**. Pumpkins are considered to be the one of the possible alternative foods in developing countries **(Agbagwa and Ndukwu, 2004)**. By **FAOSTAT (2014)** on the average world production of pumpkins are mostly involved Asia (61.6%), Europe (16.3%), America (11.7%), Africa (8.9%) and Oceania (1.4%).

The pumpkin of the *Cucurbitaceae* family is widely grown and consumed in many countries around the world **(Jun et al., 2006)**. Some varieties such as *C. moschata*, *C. maxima* and *C. pepo*, range in colour from intense yellow to orange and have revealed high levels of carotenoids, mainly α and β-carotene, β-criptoxanthin, lutein and zeaxanthin **(Boiteux et al., 2007; Rodriguez-Amaya et. al., 2008)**. This vegetable plant was very popular due to its usefulness in providing health **(Kim et al., 2012)**. The major factors of nutritional and medicinal value of pumpkin fruit are high total content of carotenoids with >80% of β-carotene **(Azevedo-Meleiro and Rodriguez-Amaya, 2007; Kurz et al., 2008)** as well as pectin and polysaccharides, minerals (potassium, phosphorus, magnesium, iron, and selenium), vitamins (C, E, K, thiamine (B1) and riboflavin (B2), piridoxine (B6)), dietary fiber, phenolic compounds (flavonoids, phenolic acids) and other substances beneficial to human health **(Sharma and Rao, 2013; Nawirska-Olszanska et al., 2014; Zhou et al., 2014)**. Because of the high content of carbohydrates and fibre, this vegetable plant has been implemented as a valuable source of dietary fibre. It may decrease the serum cholesterol level, the risk of coronary heart disease, and hypertension **(Hussain et al., 2010)**. The seed which is known to have high amount of zinc, has been used in treating the early stages of prostate problem **(Pandya and Rao, 2010)**.

Conserving and processing of pumpkin is reported as a common way of pumpkin processing: processing into jams, puree, juice pickles and dried products and it is also used as a base for soups and desserts **(Provesi et al., 2012; Assous et al., 2014)**. **Podsedek (2007)** report that during the cooking of vegetables, bioactive substances are degraded and there is absorption of water, which results in the dilution of the active ingredients.

The aim of this work was to compare the quality of selected varieties of winter squash and assessing the impact of heat treatment on the dynamics of changes in carbohydrates, total carotenoids, polyphenols and antioxidant activity.

MATERIAL AND METHODOLOGY

We used six varieties of winter squash: Liscia, Orange, Hannah, UG 201 F1, Waltham, Serpentine, which were cultivated as a part of research of the Department of Vegetable Production at the The Faculty of Horticulture and Landscape Engineering, SUA Nitra. Area is situated at an altitude of 144 m n. m. In terms of climatic conditions it belongs to the agro-climatic very warm macro-region, which is characterized by the sum of average temperatures for the main growing season (TS 10) higher than 3000 °C, with an average annual temperature of 9 to 10.2 °C, an average annual rainfall is 595 mm and an average annual amount of sunshine 2079 hours; agro-climatic sub-region is very dry with indication of irrigation in the summer months more than 150 mm and agro-climatic district of mostly mild winter (T_{min} >-18 °C) **(Špánik et al., 2008).** In terms of soil characteristics, soil is a glue fluvisol formed on alluvial sediments.

Studied varieties belong to the group of medium early to medium-late with maturing from mid-September. Hannah variety, UG 201 F1, Liscia and Waltham have pear-shaped fruits with solid orange pulp. Varieties Serpentine and Orange have softer pulp, more fibrous. Variety Orange has regular pear shape and deep orange pulp, variety Serpentine has clubbed shape and orange color flesh. Fruit harvest was performed at the stage of technical maturity when the fruits were colored and had a solid, hard skin. The average samples for analysis of monitored indicators from various parts of the fruit, free from skins and seeds were homogenized to homogeneous mass. The samples were then analyzed in the fresh matter and exposed to the effect of heat treatment in a water bath at 90 °C for 15 minutes.

Total carotenoid content expressed as beta-carotene was analyzed at a wavelength of 445 nm spectrofotometrically (VIS spectrophotometer UV Jenway Model 6405 UV / VIS). Sample (1 g) was disrupted with sea sand and extracted with acetone until complete discoloration. Petroleum-ether was added and then water, in purpose to separation of phases. After the separation the petroleum-ether-carotenoid phase was obtained and the absorbance was measured **(ČSN 560053, 1986)**.

Polyphenolic compounds were determined by spectrophotometry at the wavelength of 700 nm by the method of Folin-Ciocalteu **(Singleton and Rossi, 1965)** and expressed as gallic acid equivalent. The method is based on the reaction of Folin-Ciocalteu reagent with polyphenols, with formation of blue color. The intensity of the color is proportional to the content of polyphenols. The sample was extracted into water (at speed 200 min^{-1} for 24 h). The prescribed amount of filtrate is then mixed with the Folin-Ciocalteu agent and sodium carbonate to form a blue color.

The antioxidant activity was determined by the FOMO method **(Prieto et al., 1999)**. The principle of the method is the reduction of Mo (VI) to Mo (V) by the effect of reducing compounds in the presence of phosphorus. Resulting is green phosphomolybdate complex, the intensity of the color is measured spectrophotometrically at the wavelength 695 nm. The reducing ability of the compounds is expressed as the amount of ascorbic acid (AA) that is required to achieve the same reduction effect. The prepared extract in an amount of 1 ml was mixed with 2.8 ml of potassium dihydrogen phosphate, 6 ml sulfuric acid, 0.4 ml of ammonium molybdate and 0.8 mL of water. The solution was put in a water bath at 90 °C for 2 hours. After cooling it was analyzed spectrophotometrically.

Determination of selected carbohydrates was performed at Alpha Bruker Optik GMBH analyzer. The device works on the principle of FTIR infrared spectroscopy. The fruit juice was centrifuged and subsequently analyzed.

The results were processed by statistical program Statistica. The differences among the samples were observed by the Tukey HSD test.

RESULTS AND DISCUSSION

Loy (2004) reported that the pumpkin contains up to 70% carbohydrates in the dry matter after harvest. While in the immatured fruit prevails starch by approx. 58%, in the ripe fruit its content decreases and the dominant are simple sugars and sucrose. In our work among the observed carbohydrates the highest content was determined to be in sucrose, which is 5 – 7 times higher than the glucose and fructose (Table 1). The highest sucrose content was found in variety Liscia (55.94 g.100 g^{-1} DM) and the lowest in variety Serpentine (38.67 g.100 g^{-1} DM). Variety Serpentine showed among the varieties the lowest content of all carbohydrates observed. The highest fructose content we found at variety Hannah (12.32 g.100 g^{-1} DM) and glucose content was the highest in variety Orange (9.79 g.100 g^{-1} DM).

Content of carbohydrates in fruits of winter squash, varieties Bokor and Kelenting was observed by **Suranto et al. (2015)**. The fresh matter of Bokor variety contained 88.2% water, 9.16% carbohydrates, 1.45% proteins, 0.24% fat and 0.94% minerals. Kelenting variety was characterized by higher carbohydrate content, 10.88%. Our monitored varieties of winter squash contained water by 93.5% in the variety Serpentine to 89.2% in Waltham variety. Carbohydrates expressed per fresh matter ranged from 3.77% (Serpentine) to 7.82% (Liscia), varieties with higher carbohydrates were Liscia, Waltham and UG 205 F1.

Atef et al. (2012) investigated the carbohydrate content in different kinds of fruit and vegetable juices. In the pumpkin juice they found 5.94% carbohydrates, 11.68% in orange juice, in carrot juice 8.48% and in lemon juice 9.19%. They also compared the carbohydrate content in the pumpkin and apricot puree and its content was higher in the apricot puree, where the authors state 11.26%, while in the pumpkin puree 7.09%. Content of carbohydrates in the pumpkin puree is comparable with our results.

Iacuzzo and Dalla Costa (2009) reported the carbohydrate content in the fruit of winter squash in the amount of 6.3 to 8.7 mg. 100 g^{-1} FW. **Conti et al. (2015)** compared the carbohydrate content in the fruit cultivated under field conditions and under greenhouse. Evaluation was performed in northern Italy and variety Waltham was

Table 1 Content of saccharides in the pulp of winter squash fruit.

Variety	fructose g.100 g^{-1} FM	fructose g.100 g^{-1} DM	glucose g.100 g^{-1} FM	glucose g.100 g^{-1} DM	sucrose g.100 g^{-1} FM	sucrose g.100 g^{-1} DM	dry matter %
Serpentine	0.79	7.59[a]	0.47	7.23[a]	2.51	38.67[a]	8.4
Waltham	1.05	9.69[b]	0.99	9.23[e]	5.41	50.09[c]	13.3
Orange	0.96	10.18[c]	0.92	9.79[f]	4.42	46.99[b]	12.0
Liscia	1.09	10.41[d]	0.86	8.16[c]	5.87	55.94[f]	13.6
UG 205 F1	1.12	10.57[e]	0.93	8.74[d]	5.58	52.64[d]	12.5
Hannah	0.85	12.32[f]	0.53	7.73[b]	3.81	55.27[e]	8.6

Note: Means marked with the same letter are not statistically significantly different at $p \leq 0.05$.

used. They found that under field conditions glucose and fructose were more synthesized compared to greenhouse. The difference in sucrose content in fruits was less visible. The glucose content in fruits from outdoor (field) cultivation was 6.64 g. 100 g^{-1} DW, fructose content was 5.23 g.100 g^{-1} DW and sucrose content 39.56 mg. 100 g^{-1}, which are the results in lower amount compared to variety Waltham in our work.

After the heat treatment of the pumpkin pulp, we found a decrease in the sucrose content, an increase in glucose and fructose content (Table 2). All changes that occurred by heat treatment based on the results of multifactor analysis of variance were statistically significant (Table 3).

As reported several authors fruits of winter squash are characterized by the presence of the contents of various bioactive substances, in particular carotenoids. **Murkovic et al. (2002)** state that in pumpkin pulp, β-carotene, α-carotene and lutein are present. **Azevedo-Meleiro and Rodriguez-Amaya (2007)** investigated the dominant carotenoids in three species of the genus Cucurbita. *Cucurbita moschata* contains β- and α-carotene, in hybrid varieties was found lutein as well. *Cucurbita pepo* and *Cucurbita maxima* showed especially lutein and β-carotene content. **Provesi et al. (2011)** reported that beside dominant β- and α-carotenes in fruits as minor are represented lutein, violaxantine, ζ-carotene.

Content of total carotenoids expressed as β-carotene was observed in our samples from 4.10 mg.100 g^{-1} FM in variety Liscia to 9.18 mg.100 g^{-1} in Orange variety. Converting this content per dry matter, we found that among all samples are statistically significant differences, the highest value is confirmed by variety Orange (97.67 mg.100 g^{-1} DM) and the lowest in variety Liscia (39.01 mg.100 g^{-1} DM). Higher content of total carotenoids we found in the sample Hannah (92.42 mg.100 g^{-1} DM) and low in the sample UG 205 F1 (56.55 mg.100 g^{-1} DM) (Table 4).

In studies of **Andrejiová et al. (2014)** the content of total carotenoids in pumpkin pulp of variety Orange was detected 15.10 mg.100 g^{-1} FW and in variety Liscia 9.33 mg.100 g^{-1} FW. They state that after 6 months of storage, the total content of carotenoids increased, and ranged from 14.27 to 31.87 mg.100 g^{-1}.

Kurz et al. (2008) observed the content of carotenoids in fruits of pumpkins cultivated in Germany and found that α-carotene content was from 0.058 to 1.06 g mg.100g^{-1} and β- carotene content ranged from 0.90 to 1.14 mg.100g^{-1}. **Murkovic et al. (2002)** observed the content of carotenoids cultivated in Austria and the highest carotenoid content was determined in variety Long Island Cheese, 5.9 mg.100 g^{-1} FW of α-carotene, 7.0 mg.100 g^{-1} of β-carotene and 0.14 g mg.100 g^{-1} lutein. **Jaswir et al.**

Table 2 Content of saccharides in the pulp of winter squash fruit after heat tretment.

Variety	glucose g.100 g^{-1} FM	glucose g.100 g^{-1} DM	fructose g.100 g^{-1} FM	fructose g.100 g^{-1} DM	sucrose g.100 g^{-1} FM	sucrose g.100 g^{-1} DM
Hannah	0.84	9.80	1.26	14.69	3.97	46.12
UG 205 F1	1.21	9.68	1.57	12.13	5.74	45.95
Liscia	1.25	9.16	1.43	10.52	6.07	44.63
Waltham	1.35	10.18	1.41	10.60	5.34	40.18
Orange	1.22	10.14	1.29	10.78	4.65	38.72
Serpentine	0.82	9.76	0.79	9.41	2.73	32.460

Table 3 The average content of carbohydrates (g.100 g^{-1} DM) in fresh pulp and after heat treatment in winter squash and homogeneous groups based on the multifactor analysis.

Saccharide	form	number of measurements	mean	Homogeneous group
fructose	fresh	18	10.12	a
	heat treatment	18	11.35	b
glucose	fresh	18	84.79	a
	heat treatment	18	97.88	b
sucrose	fresh	18	49.93	b
	heat treatment	18	41.34	a

Note: Means marked with the same letter are not statistically significantly different at $p \leq 0.05$

Table 4 Total carotenoids, polyphenols and antioxidant activity in pulp of winter squash fruit.

Variety	Total carotenoids mg.100 g^{-1} FM	Total carotenoids mg.100 g^{-1} DM	Total polyphenols mg GAE.100 g^{-1} FM	Total polyphenols mg GAE.100 g^{-1} DM	Antioxidant activity mg AA.100 g^{-1} FM	Antioxidant activity mg AA.100 g^{-1} DM
Liscia	4.10	39.01^{a}	46.61	443.98^{a}	85.71	816.34^{c}
Orange	9.18	97.67^{f}	42.01	446.93^{a}	63.93	680.18^{a}
UG 205 F1	5.99	56.55^{b}	48.45	457.11^{b}	87.98	829.96^{cd}
Waltham	8.07	74.76^{d}	50.02	463.21^{c}	92.00	851.87^{d}
Serpentine	4.33	66.57^{c}	32.50	499.98^{d}	46.90	721.58^{b}
Hannah	6.38	92.42^{e}	39.01	565.44^{e}	56.34	816.49^{c}

Note: Means marked with the same letter are not statistically significantly different at $p \leq 0.05$
GAE – gallic acid equivalent, AA – ascorbic acid equivalent.

(2014) monitored the content of β-carotene in winter squash cultivated in Malayzia area harvested at different times during the year. The highest carotenoid content was found in fruits harvested in February, the lowest content in the fruit harvested in November, mean content was found in June. The β-carotene content in fruits grown in Malayzia ranged from 1.52 to 4.14 mg.100 g^{-1} fresh matter, which is comparable with our results.

Similarly high levels of total carotenoids are given by **Jacobo-Valenzuela et al. (2011)**, who analyzed the fruits grown in Mexico and state that the average content of total carotenoids in variety Cehualca was 2.67 mg.100 g^{-1}. Content of total carotenoids in variety Menina Brasileira harvested in Brazil evaluated **Provesi et al. (2012)** and determined the content 3.77 mg.100 g^{-1}. **Iacuzzo and Dalla Costa (2009)** observed carotenoids in varieties Red Kury, Tan Chesse and Kabosha grown in southern Italy. Content of carotenoids detected in the amount of 7.6 mg.100 g^{-1} FM was found to be in variety Red Kury and low levels 1.1 to 1.5 mg.100 g^{-1} in varieties Kabosha and Tan Chesse.

After the heat treatment, the amount of total carotenoids decreased (Table 5). Based on the results of multifactor analysis of variance, we found that this difference was statistically significant. The average decrease of total carotenoids after heat treatment was 37.19%.

Azizah et al. (2009) performed the experiment with a short heat treatment of pumpkin in boiling water at 100 °C and frying at 170 °C for 1 – 6 minutes. At cooking they found that by the prolongation of the time the β-carotene content of the pulp decreases, but at frying by the extension of the time up to 6 minutes, the β-carotene content was getting higher. They explain their results by using of a frying oil that leads to better solubility of the carotenoids. They also show better bioavailability of carotenoids due to the degradation of cellulose during the heat treatment.

Provesi et al. (2011) report that under the heat treatment there is a reduction of carotenoid content in the pumpkin puree, retention of the content of carotenoids as a whole can be up to 75%, this result corresponds with our results. Authors state that the decrease occurs primarily in the content of xanthophylls, which contain in the structure one or two molecules of oxygen and can be due to the heat treatment completely degraded (especially xanthophylls, which can be completely degraded. This group of carotenoids has one or more oxygen groups in its structure, has lower stability during processing and storage). High stability during processing showed α-carotene and all-trans-β-carotene.

Zdunić et al. (2016) processed the pumpkin into various food products, such as pumpkin jam, pumpkin sweet wine or pumpkin juice. They show that during processing in each product, the decrease of the content of total carotenoids is observed. The smallest decrease only 30% was recorded in the production of pumpkin jam, while a significant decrease occurred in the processing of pumpkin into sweet wine and the juice, where the carotenoid content decreased by 70%. Also **Caili et al. (2006)** report that the decrease in carotenoids in pumpkin products is greatly affected mainly by technological process of production and especially by the use of heat treatments. **Provesi and Amante (2015)** state that processing of the pumpkin can cause oxidation or isomerisation of carotenoids, which affect the biological activity and color of the products. The most important factors leading to the loss of carotenoids include the temperature, contact with oxygen and light.

Content of polyphenolic compounds and antioxidant activity are the parameters, between which there is usually a strong correlation dependence **(Zdunić et al., 2016)**. **Zdunić et al. (2016)** observed the identification of phenolic compounds in winter squash and in the fruit they described seven compounds. As dominant were protocatechuic acid and chlorogenic acid. **Dragovic-Uzelac et al. (2005)** reported the presence of chlorogenic acid in fruits of C. pepo, C. maxima and C. moschata. **Zdunić et al. (2016)** indicate the presence of hesperidin in the fruit, that occurs mainly in citrus fruits and has strong antioxidant, anti-inflammatory and anti-cancer activity **(Manthey et al., 2001; Wilmsen et al., 2005).** Eriodictyol 7-neohesperidoside is also another group of polyphenolic compounds, which in winter squash was detected by **Zdunić et al. (2016)** and is considered as a powerful antioxidant. In small amounts they reported the presence of salicylic acid, p-hydroxybenzoic acid and p-coumaric.

The total content of polyphenolic substances in our samples ranged from 443.98 mg GAE.100 g^{-1} to 565.44 mg GAE.100 g^{-1}. The results of antioxidant activity ranged in our samples from 680.18 mg AA.100 g^{-1} to 851.89 mg AA.100 g^{-1}. The lowest content of total polyphenols we found in varieties Liscia and Orange, between them no statistically significant difference was detected. Liscia variety is also characterized by low content of carotenoids, in contrast to the variety Orange, that by the content of carotenoids dominated among evaluated varieties. The highest polyphenol content we found at variety Hannah, that is variety belonging to the

Table 5 Content of total carotenoids, polyphenols and antioxidant activity in pulp of winter squash fruit after heat treatment.

Variety	Total carotenoids mg.100 g^{-1} FM	mg.100 g^{-1} DM	Total polyphenols mg GAE.100 g^{-1} FM	mg GAE.100 g^{-1} DM	Antioxidant activity mg AA.100 g^{-1} FM	mg AA.100 g^{-1} DM
Liscia	3.93	28.90	42.53	312.76	87.03	639.92
Orange	7.18	59.81	34.71	289.24	78.47	653.94
UG 205 F1	5.58	44.63	40.10	320.81	87.02	696.58
Waltham	6.5	48.85	49.24	370.23	87.16	655.31
Serpentine	2.82	33.58	18.19	216.56	47.47	565.09
Hannah	3.72	43.26	23.55	273.81	59.98	697.46

GAE- gallic acid equivalent, AA- ascorbic acid equivalent.

Table 6 The average content of total carotenoids, polyphenols and antioxidant activity in pulp of winter squash fruit and after heat treatment and homogeneous groups based on the multifactor analysis.

Parameter	form	number of measurements	mean	Homogeneous group
total carotenoids	fresh	18	71.16	a
	heat treatment	18	43.17	b
total polyphenols	fresh	18	479.44	a
	heat treatment	18	297.23	b
antioxidant activity	fresh	18	786.07	a
	heat treatment	18	651.39	b

Note: Means marked with the same letter are not statistically significantly different at $p \leq 0.05$.

higher contents of carotenoids as well. The highest antioxidant activity reached variety Waltham (851.87 mg AA.100 g^{-1}) and the lowest variety Orange (680.18 mg AA.100 g^{-1}). Waltham variety was one of the varieties with higher contents of total carotenoids and total polyphenols. Variety Orange showed one the lowest content of total polyphenols as well.

Polyphenol content in pumpkin cultivated in Malaysia evaluated **Azizah et al. (2009)** and in fresh matter they report it >90 mg.100 g^{-1}, which is higher than we found in our work. **Zdunić et al. (2016)** state the polyphenol content in pumpkin grown in Serbia to be 90.59 mg.100 g^{-1} FW, which is higher than we found in our work. **Nawirska-Olzańska et al. (2011)** performed an experiment in the Experimental Station of Wroclaw University of Environmental and Life Sciences in Psary and total polyphenol content detected in winter squash was 23.64 mg.100 g^{-1}, compared to our results it is lower result.

After the heat treatment in all varieties some decrease in the total polyphenol content and antioxidant activity was recorded as well. These changes based on the results of the Multi-factorial analysis of variance, similarly as in the case of total carotenoids, were statistically significant. The most significant change in the content of total polyphenols occured in variety Serpentine, the polyphenol content decreased by 56.69%. Good stability of the total polyphenols showed variety Waltham, it maintained up to 79.93% of the original content.

The stability of total polyphenols by different methods of heat treatment in winter squash monitored **Azizah et al. (2009)**. Comparing the impact of cooking and frying on the polyphenol content they state that for both types of processing its content is decreasing, and there is no difference between the impact of cooking and frying. The longer is the material affected by both ways, the more decrease can be seen. **Zdunić et al. (2016)** investigated changes in polyphenol content after production of pumpkin wine, jam, and juice, and they have found that the greatest decreases are occurring in the production of pumpkin juice when from the original content 90.59 mg.100 g^{-1} in the product is maintained only approximately 10% of the initial quantity of total polyphenols. The smallest change occurred in the production of pumpkin jam

CONCLUSION

Winter squash belongs to the less widespread and unusual vegetables in Slovakia. In the world, especially in South America and Asia, it is one of the crops with a long history of cultivation due to the good climatic conditions of the locations, high biological potential of the crop itself and application in nutrition. The aim of the work was to compare the quality of selected types of winter squash in terms of carbohydrate content, total carotenoids and polyphenols and antioxidant activity and assessment of the changes that occur after heat treatment. Studied varieties were characterized by relatively high carbohydrate content. From the observed carbohydrates in fruits dominated sucrose, which was present in an amount of 28.67 g.100 g^{-1} DM to 55.27 g.100 g^{-1} DM. After heat treatment of pumpkin pulp sucrose content decreased and glucose and fructose content increased. Total carotenoids ranged from 39.01 g mg.100 g^{-1} DM to 97.67 mg.100 g^{-1} DM, the highest content we found in Orange variety. Heat treatment in the pulp was the reason of decreased content of carotenoids. The same effect showed heat treatment on the total polyphenols and antioxidant activity. Total polyphenols in fruits was detected from 443.98 mg GAE.100 g^{-1} DM to 565.44 mg GAE.100 g^{-1} DM. The highest content of total polyphenols we found in variety Hannah. The antioxidant activity of observed varieties ranged from 680.18 mg AA.100 g^{-1} DM to 851.87 mg AA.100 g^{-1} DM . The highest antioxidant activity showed variety Watham.

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