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EVALUATION OF THE CONTENT OF PIGMENTS AND TOTAL SUGARS IN GROUND SWEET PEPPER

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ABSTRACT

The aim of this research was to evaluate and compare the content of pigments and total sugars in raw materials of both the domestic as well as foreign origin that are used in the production of sweet ground pepper. The tests included two samples exported from abroad, specifically from Serbia and China and the following domestic varietes of *Capsicum annum* L.: Kolora, Žitava, Dvorská (varieties that form the base of the final product called Paprika Žitava/Žitavská paprika and a mix of a number of domestic varieties called Slovenský polotovar. The tests were conducted in 2015 and 2016. The highest content of pigments in both years was contained in Dvorská and Kolora – 6.81 and 6.11 $g.kg^{-1}$. The largest amount of total sugars was recorded within Žitava in 2015 (20.5%) and in 2016 Slovenský polotovar with 24.5%. Both the exported as well as domestic products fulfilled the parameters of quality required in the production of sweet pepper.

Keywords: sweet ground pepper; total sugars; content of pigments

INTRODUCTION

Peppers, *Capsicum annum* L.var. longum, are a variety which belong to well-known commercial and industrial plants **(Lim, 2013)**. This species boasts wonderful spice qualities. It gives delicious taste, smell and colour to all different dishes. It is used both in fresh as well as dried form. There is a higher consumption of the sweet pepper, but hot pepper is also popular. Mature peppers are dried and ground until fine powder is made **(Rehuš and Valšíková, 2016)**. In Slovakia, the consumption of sweet ground pepper per capita is 100 – 200 g a year **(Valšíková, Červenka and Sudzina, 2010)**.

According to **Habán, Černá and Dančák (2001)**, the consumption of sweet pepper in Slovakia has increased from 50 to 100 g per capita a year. Usage of spices such as paprika or pepper spices are also of great economical interest **(Škrovánková et al., 2017)**. Nowadays, only around half the volume of the Slovak consumption of peppers is produced in the territory of Slovakia, the rest is transported from abroad. The production of spice pepper in the most fertile districts of Slovakia is gradually decreasing, as is the production of sweet peppers. **(Valšíková, Ryban and Srničková, 2014)**. One of the most important qualitative parameters of sweet pepper is the content of carotenoid pigments and total sugars. Pepper fruits include carotenoid pigments, mainly carotene, capsanthin, cryptoxanthin, lutein and zeaxanthin. The amount of red pigments determines the colour intensity of the final product **(Muchová et al., 2001)**. Capsorubin is the main colouring constituent. From the total amount of sugars, peppers contain 90 – 98% of dextrose, the rest is accounted for fructose and sucrose.

The final quality of the products is influenced mainly by the quality of fruits as well as by the processing technology – drying and grinding. „Paprika Žitava/Žitavská paprika“, which was entered in the register of protected designations of origin and protected geographical indications by the European Commission on the 11th of February 2014 **(Commission Regulation (EU) no. 126/2014)**, belongs to a group of products with superb quality. Paprika Žitava is sweet ground pepper made by grinding the dried spice pepper fruits harvested in the area of Podunajská nížina (Danubian Lowlands). The fruits are state-recognized varieties that are picked intact when ripe and then they undergo a special postharvest treatment.

„Paprika Žitava/Žitavská paprika“ gets its characteristic intense colour from the final stage in the grinding process on what is known as the ‘colouring stone’; as pressure is applied, the temperature rises and the oil contained in the seeds is released, which is what imparts the characteristic orange-red colour **(Council Regulation (EC) No 510/2006)**.

Scientific hypothesis

The pigments and sugars in the ground spice pepper form the taste and intense red colour. Their content depends on many cultivation and processing conditions. Therefore, we assume a significant difference between the years under review. The content of dyes and sugars is also one of the varietal properties. It is assumed that we will find differences between varieties. We expect above-average

sugar and pigments content in the final product of ground pepper called "Paprika Žitava / Źitavská paprika".

MATERIAL AND METHODOLOGY

Raw material

The Slovakian company Mäspoma, spol. s.r.o Zvolen, plant mill for processing spices – Dvory nad Žitavou provided all the following raw materials, final products and information about the production and evaluation of all samples. The company also has a laboratory, where part of all of the laboratory experiments took place. The samples were evaluated during the years 2015 and 2016.

We used strictly specified procedures of sampling, samples were taken from a number of bags. Five fractional samples of about 100 g were taken from each bag. The fractional samples were mixed, the average sample was ground in the laboratory to be consequently sieved through a 0.5 mesh size sieve. The sample, gained in the above described method was then evaluated by means of subjective as well as objective methods.

The following samples were included in the laboratory experiments:

The domestic varieties of the *Capsicum annum* L.: Žitava, Dvorská and Kolora.

The mix of a number of domestic varieties called Slovenský polotovar, which is used as a feedstock for making different spice mixtures according to the requirements of consumers.

Different transported raw materials used to make sweet pepper from Serbia and China. These two countries are the main exporters to Slovakia and their products are used in the production of spice mixtures.

The final product of ground pepper called „Paprika Žitava/Žitavská paprika“ (Figure 3 and Figure 4).

Laboratory Methods

Determination of Pigments in ground sweet pepper according to STN EN ISO 7541:1989

The spectrophotometric method was used to quantify the content of carotenoids. Sweet paprika in the amount of 0.5 g was placed into a dark reagent bottle and 50 mL of acetone was added. The sample was swirled thoroughly and left to stand for 30 minutes. 5 mL of the sample was pipetted into a 50 mL volumetric flask, which was filled up to the mark with acetone and swirled thoroughly. Absorbance was measured using a wavelength of 477 nm in a photospectrometer SPEKOL 11 (spectral colorimeter) made by Carl Zeiss Jena, Germany.

Calculation of pigments in $g.kg^{-1}$:

$$C = \frac{A \times f \times 2.5 \times 10^5}{2250 \times (100 - H) \times m}$$

where:
A – the absorbance of the test solution,
f – the correction factor,
H – the moisture content of the test sample,
m – the mass, in grams,
2250 – the absorption cofficient of capsanthin,
2.5×10^5 – a conversion factor.

Determination of Total Sugars according to Somogyi

The free hemiacetal group of sugars is characterised by its reducing properties.

The reducing sugars when heated with alkaline copper tartrate included in the Somogyi solution reduce the copper from the cupric to cuprous state and thus cuprous oxide is formed. When cuprous oxide is treated with arsenomolybdic acid, the reduction of molybdic acid to molybdenum blue takes place. Based on its intensity the content of reducing sugars is determined at a wavelength of 710 nm in a spectrophotometer Specord 50 Plus by Analytikjena, Germany. The distributor of this chemical is company MikroChem Trade, Pezinok, Slovakia. The acid hydrolysis then determines the amount of total sugars. The difference in both determinations gives the content of non reducing sugars **(Repčák et al., 2015)**.

Káš, Kodíček and Valentová (2006) describes the following steps of the analysis: Fill the given amounts of stock solution in the following amounts: 0; 0.2; 0.4; 0.6; 0.8; 1 mL into prepared laboratory tubes and add distilled water up to 1 mL. One mL of Somogyi solution is then added to Each laboratory tube, it is heated in a hot bath for 15 minutes. After they have cooled down, 2 mL of Nelson agent are added, swirled well and then 10 mL of distilled water is added. The intensity is then measured by the formed colour of the blue-green colour of the solution that is formed.

Statistical analysis

The results of the laboratory experiments were processed by standard statistical methods using statistical software Statgraphics Centurion XVII (StatPoint Inc, USA) – means of multiple comparison analysis testing – ANOVA test (multiple range test) and 95.0 percent LSD test .

Table 1 Average Content of Pigments and Total Sugars.

Years	Variety	Pigments in g.kg^{-1}	Total sugars in %
2015	Paprika Žitava	6.22	20.50
2015	Slovenský polotovar	5.55	20.00
2015	Chinese	6.54	18.25
2015	Serbian	5.59	17.30
2015	Dvorská	6.68	11.50
2015	Kolora	6.68	8.40
2015	Žitava	5.42	5.85
2016	Paprika Žitava	6.38	21.00
2016	Slovenský polotovar	4.93	24.50
2016	Chinese	5.29	14.50
2016	Serbian	5.01	18.00
2016	Dvorská	6.94	11.70
2016	Kolora	6.11	7.25
2016	Žitava	5.94	15.20

Table 2 Multiple Range Test for Pigments g.kg^{-1} (Method: 95.0 percent LSD).

Variety	Years	Count	LS Mean	LS Sigma	Homogeneous Group
ZI	2015	3	5.42333	0.0409768	X
SP	2015	3	5.55667	0.0409768	X
SR	2015	3	5.59333	0.0409768	X
PZ	2015	3	6.22667	0.0409768	X
CH	2015	3	6.54333	0.0409768	X
DV	2015	3	6.68	0.0409768	X
KO	2015	3	6.68333	0.0409768	X
SP	2016	3	4.93	0.0757677	X
SR	2016	3	5.01667	0.0757677	X
CH	2016	3	5.29667	0.0757677	X
ZI	2016	3	5.94667	0.0757677	X
KO	2016	3	6.11	0.0757677	X
PZ	2016	3	6.38667	0.0757677	X
DV	2016	3	6.94667	0.0757677	X
Yeas	Count	LS Mean	LS Sigma		Homogeneous Group
2015	21	5.80476	0.0767936		X
2016	21	6.10095	0.0767936		X

Notes: PZ – Paprika Žitava, SP – Slovenský polotovar, SR – serbian sample, CH – chinese sample, DV – Dvorská, KO – Kolora, ZI – Žitava.

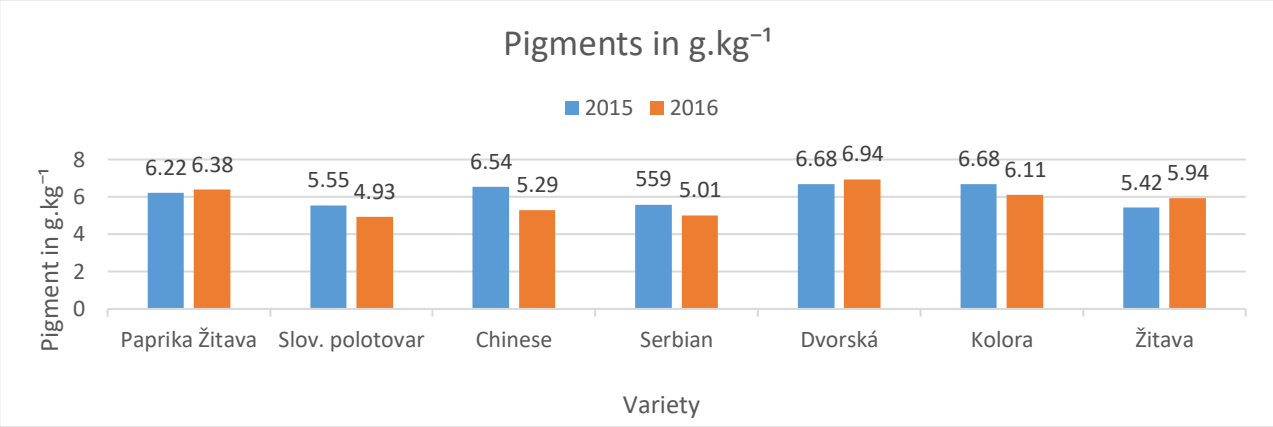

Figure 1 Contents of pigment in g.kg^{-1}.

Table 3 Multiple Range Test for Total sugars in % g.kg^{-}$_{1}$ (Method: 95.0 percent LSD).

Variety	Years	Count	LS Mean	LS Sigma	Homogeneous Group
SP	2015	3	5.24333	0.143668	X
SR	2015	3	5.305	0.143668	XX
ZI	2015	3	5.685	0.143668	XX
CH	2015	3	5.92	0.143668	XX
PZ	2015	3	6.30667	0.143668	XX
KO	2015	3	6.39667	0.143668	X
DV	2015	3	6.81333	0.143668	X
KO	2016	2	7.825	2.12656	X
ZI	2016	2	10.525	2.12656	XX
DV	2016	2	11.6	2.12656	XX
CH	2016	2	16.375	2.12656	XX
SR	2016	2	17.65	2.12656	XX
PZ	2016	2	20.75	2.12656	X
SP	2016	2	22.25	2.12656	X
Yeas	**Count**	**LS Mean**	**LS Sigma**		**Homogeneous Group**
2015	7	14.5429	1.13669		X
2016	7	16.0214	1.13669		X

Notes: PZ- Paprika Žitava, SP – Slovenský polotovar, SR – serbian sample, CH – chinese sample, DV – Dvorská, KO – Kolora, ZI – Žitava.

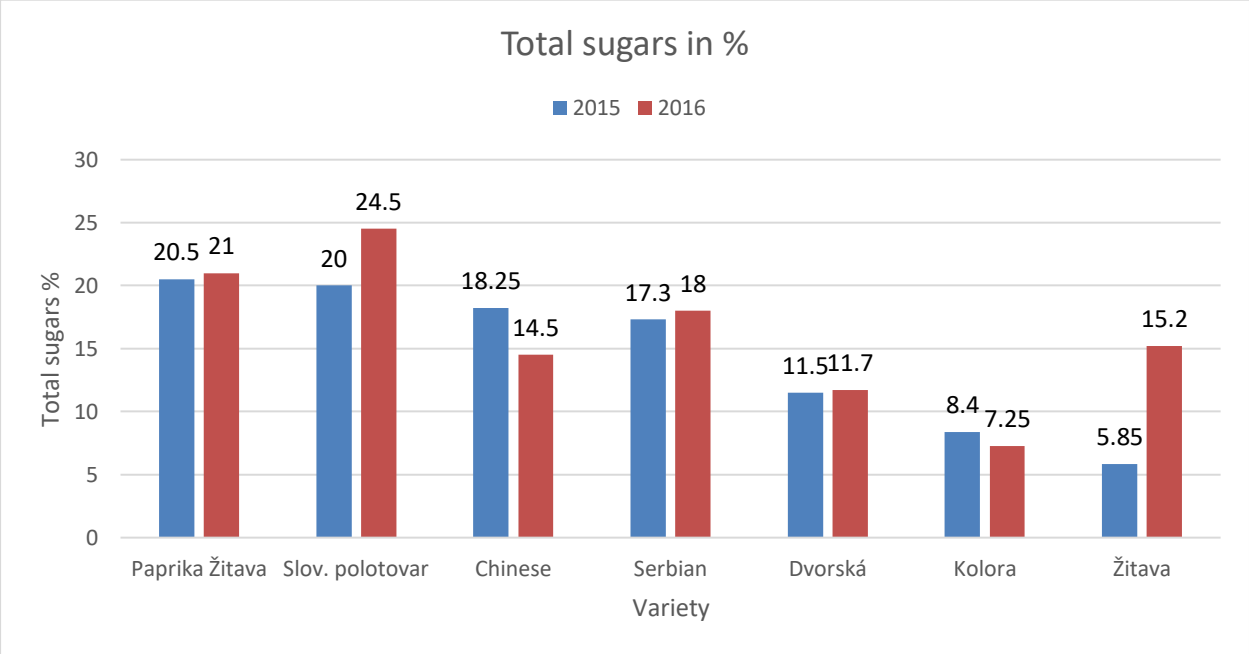

Figure 2 Contents of total sugars in %.

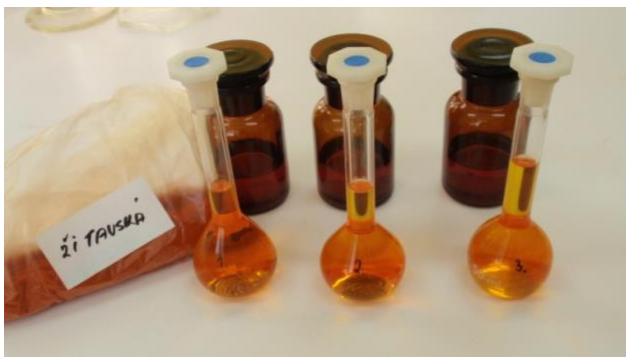

Figure 3 Varieta Žitavská – samples for testing.

Figure 4 Sample Žitavská – dry fruit, powder.

RESULTS AND DISCUSSION

The laboratory analyses determined the content of pigments and sugars in 6 samples of ground sweet pepper. In 2015 the highest content of pigments was discovered in these varieties: Dvorská and Kolora, equally 6.68 $g.kg^{-1}$ and the lowest content was determined within the variety Žitavská 5.42 $g.kg^{-1}$ (Figure 1).

In 2016 the highest content of pigments we find in the variety Dvorská 6.94 $g.kg^{-1}$ and the lowest content 4.93 $g.kg^{-1}$ in Slovenský polotovar (Figure 1).

In 2015 the highest average content of total sugars we confirmed in Paprika Žitava (20.5%) and in Slovenský polotovar (24.5%) in 2016. The lowest content of total sugars in 2015 we discovered in the variety Žitava (5.85%). In 2016 the variety Kolora showed the lowest content of total sugars (7.25%) (Figure 2). The most important requirement of ground red pepper is the pigment content. Pigment synthesis begins on the plant during growing and ripening. Later after harvest and continues throughout the drying **(Kerek et al., 2015)**.

Table 1 shows the observed average results as discovered over the duration of two years.

Evaluation of pigments content

The analysis of variance done for the samples of ground sweet pepper in 2015 showed statistically significant differences in the content of pigments (diff. = 013 – 1.26; α <0.05) in the majority of samples.

However, the samples of Dvorská – Kolora and Slovenský polotovar – Serbian did not show any statistically significant differences in the content of pigments (Table 2).

The year 2016 also proved statistically significant differences in the content of pigments of the majority of analyzed samples (diff. -1.65 – 2.02; α <0.05). The samples Kolora – Paprika Žitava and Slovenský polotovar and the Serbian sample did not show any statistically significant differences in the content of pigments (Table 2).

The multiple comparison method proved a statistically significant difference in the contents of pigments in between the years 2015 and 2016 (0.0296; α <0.05) (Table 2).

Evalution of total sugars content

The sweetness of ground paprika is a very important quality factor that affects the popularity of consumers. According to **Kyung-Hyung, Yung-A and Jae-Bok (2012)** was a total sugar content of 16.79 – 29.92%, glucose, fructose and sucrose content was 5.6 – 11.2%, 8.91 – 16.89%, and 1,78 – 2.97%. In our experiments the highest average content of total sugars was determined in 2015 within Paprika Žitava/Žitavská paprika – 20.5% and in 2016 it was the sample of Slovenský polotovar with 24.5%. The lowest content of total sugars in 2015 was recorded within the variety Žitava (5.85%) and within the variety Kolora (25%) in 2016 (Figure 2). The average results as recorded over the duration of two years are shown in the Table 1. Other authors also report the total sugar content of 20.44**% (Habán, Černá and Dančák, 2001; Bojňanská, 2004)**. **Sharma, Joshi and Kaushal (2015)** found total sugars in the dry ground pepper spice between 8.68 and 9.10%.

Comparison of the percentage content of total sugars in between 2015 and 2016 showed a statistically significant difference in the content of sugars (p = 0.019) and in the content of sugars among the following samples Chinese – Kolora, Dvorská – Paprika Žitava, Dvorská – Slovenský polotovar, Kolora – Paprika Žitava, Kolora – Serbian, Paprika Žitava – Žitavská, Slovenský polotovar – Žitavská (diff. -14.43 – 11.73; α <0.05) (Table 3).

CONCLUSION

Over the year 2015 and 2016 the laboratory tests examined the content of sweet pepper pigments as recorded from the dry matter. The average content of pigments ranged between 5.42 – 6.68 $g.kg^{-1}$.

The highest content of pigments was recorded in the following varieties Dvorská and Kolora, variete Dvorská 6.94 $g.kg^{-1}$ (2016) and 6.68 $g.kg^{-1}$ (2015), and Kolora 6.68 $g.kg^{-1}$ (2015) and 6.11 $g.kg^{-1}$ (2016). The sample Paprika Žitava also showed high contents of pigments during both years 2015 and 2016 – in 2015 it was 6.22 $g.kg^{-1}$ and in 2016 it was 6.38 $g.kg^{-1}$. The products bought abroad also showed high contents of pigments, the Chinese sample had the following average content of pigments 6.54 $g.kg^{-1}$ in 2015 and 5.29 $g.kg^{-1}$. The lowest content of pigments was recorded in the sample Slovenský polotovar (4.93 $g.kg^{-1}$) in 2016. The tests also found statistically significant differences in the average content of pigments in the majority of varieties as well as in different years.

The average content of total sugars ranged in the analysed years from 5.85% (Žitavská, 2015) up to 24.5% (Slovenský polotovar, 2016).

In 2015 it was Paprika Žitava which achieved the highest content of total sugars (20.5%) and Slovenský polotovar (24.5%) in 2016. Žitava also recorded the average content of sugars above 20% in both analyzed years and truly the sweetness is its most distinguishing feature. The majority of samples also showed statistically significant differences in the content of total sugars as well as in the analyzed years.

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