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Content of Selected Nutritional Element in Fruits of Several Pepper Cultivars

Zawartość wybranego składnika odżywczego w owocach kilku odmian papryki

Abstract. Pepper belongs to the important sources of vitamin C, carotenoids or other nutrients. This paper describes results of the nutritional analysis of fruits of chosen pepper cultivars grown in the field conditions. There were compared fruits in green and red stage and two dates of harvest time. The mean analysed nutrients content in fresh green and red pepper fruits were: total dry matter 11%, refractometric dry matter 6 to 8° Bg, reducing sugars 34-43 g · kg^{-1}, total carotenoids 313-757 mg · kg^{-1}, vitamin C 1690–2133 mg · kg^{-1}, potassium 2370 mg · kg^{-1}, calcium 61 mg · kg^{-1}, magnesium 166 mg · kg^{-1} and sodium 34 mg · kg^{-1}. The cultivar was confirmed as a significant factor influencing all analysed nutrients. The effect of ripening stage of fruits was also found as statistically important in most cases. The effect of year and date of harvest showed variable significance on the selected compounds.

Key words: pepper, nutritional quality, cultivar

INTRODUCTION

Pepper belongs to the one of the most valuable vegetables according to the nutritional quality of its fruits. This vegetable is rich in vitamin C, carotenoids, sugars and other compounds (Hermann, 1995).

A numbers of factors influence the final nutritional value of harvested fruits. Climate conditions (temperature, sunshine, etc), soil characteristics or irrigation are counted as such factors (Wall et al., 2001). Internal genotype characteristics also contribute to different values of fruit composition (Bosland and Votava, 2000). Besides the cultivar, importance should be attached to the time of harvest or stage of fruit development (Kim et al., 1995).

This paper describes results of field experiments with selected pepper cultivars, which were evaluated for the content of vitamin C, total carotenoids, reducing sugars, some mineral elements, refractometric and total dry matter.

MATERIAL AND METHODS

Field experiments were carried out in test plots of Faculty of Horticulture in Lednice. The soil reaction and content of macroelements in soil as well as dates of most important treatments in the experiment are presented in Tab. 1. Mean air temperature was 16.3°C and 17.1°C. the during growing season 2001 and 2002, respectively. The sum of sunshine reached 1231 and 1323 hours during the same periods.

Tab. 1. Conditions of field experiments

Year	Content of macroelements (mg · kg^{-1})						Date of		
							sowing	planting	harvest
	pH	Nmin	P	K	Ca	Mg			
2001	7,3	26	299	510	5138	378	10.3.	29.5.	19.9., 23.10.
2002	7,3	25	313	492	5005	394	13.2.	21.5.	10.9., 15.10.

Nine cultivars originated in the Czech Republic ('Andrea', 'Beros', 'Jova', 'Korál', 'Maryša', and PCR) or in Slovakia ('Eva', 'Granova', 'Rubinova') were evaluated in the experiment. This group was completed by the Czech cultivar of sweet spicy type pepper Karkulka.

The planting material was prepared in the greenhouse conditions (18/16°C) in plugs with size of 35 mm. Two plants were planted together in the one position by hand. Plant distance was 0.5 x 0.3 m.

The soil analysis was made before planting by the Mehlich III method. According to the results of this analysis, calcium nitrate was applied to reach the level of 113 kg N · ha^{-1}.

Fruit samples were harvested in the green stage (processing maturity) and in the red stage (physiological ripeness). One sample consisted of 3 typical and size-developed fruits and each cultivar was evaluated in 4 replications in each harvest date.

Statistical analysis was performed in statistical software Unistat 5.1 (Unistat, USA). Significance of differences was evaluated using the method of least significant difference (LSD) at 95% probability level.

ANALYTICAL METHODS

Fresh fruit samples were immediately processed for the analysis of sensitive compounds by homogenization in stainless mixer Eta (Eta, Czech Republic). All chemicals had purity "for analysis" or "HPLC grade". Sample preparation was made using demineralised water.

Samples for determination of vitamin C content were after homogenization and purification by centrifuge Hettich EBA 12 (Hettich, Germany) directly in-

jected to the HPLC system. Analysis of vitamin C (ascorbic acid) was done by reverse phase HPLC at 254 nm on column CGC Separon C18 150 x 4,6 mm (Tessek, Czech Republic) by chromatograph Ecom (Ecom, Czech Republic). The mobile phase consisted of tetrabutylammonium hydroxide, oxalic acid and water; the flow was 0.5 ml per minute.

The content of total carotenoids was analysed by spectrometry at 440 nm wavelength in the spectrometer Jenway 6100 (Jenway, Great Britain). Samples for carotenoid analysis were extracted by the IKA extractor (IKA, Germany) during 8 extraction cycles (total time 160 minutes) in acetone. Elimination of light was assured using dark lab glass and other lab equipment. Samples were purified by centrifugation before measurement.

Sugar content was determined as a sum of glucose and fructose by reflectometric method in the RQflex II (Merck, Germany) directly after sample homogenization and dilution of obtained fruit sap by distilled water.

Content of potassium, calcium, sodium and magnesium was determined by capillary isotachophoresis at Ionosep 900.1 (Recman, Czech Republic). Samples were after digestion with sulphuric acid diluted and directly analysed during a 15 minutes analysis. Leading electrolyte consisted of 7.5 mM sulphuric acid +7 mM 18-crown-6 + 0.1% hydroxypropyl methylcellulose and the content of terminating electrolyte was 10 mM bis-tris-propane +5 mM acetic acid.

Dry matter of fruits was determined after drying of samples in oven Sterimat 574.2 (BMT, Czech Republic) at 105°C till the samples reached constant weight. Refractometric dry matter was analysed by the handy refractometer RR 12 (PZO, Poland) in squeezed fruit sap.

RESULTS

Results illustrating the content of analysed compounds in green and red pepper fruits are presented in Tab. 2.

The total dry matter made 10% and 12% of green and red fruits fresh weight on average, respectively. Its highest content at both fruit stages (20 and 23%) was found in fruits 'Korál' cv. in. Green fruits contained 5.8 °Bg of refractometric dry matter on an average, however its content in fruits 'Beros' cv. reached the level of 9.8 °Bg. Mean refractometric dry matter content in red fruits was 8,2 °Bg and fruits 'Korál' cv. were richest in this element.

Mean content of reducing sugars was 34 g · kg^{-1} in green and 43 g · kg^{-1} of f.m. in red fruits. Reducing sugar content increased during harvest period. The highest level in both types of fruits (47 and 51 g · kg^{-1}) was found in cv. 'Maryša'.

Tab. 2. Mean content of analysed compounds in pepper fruits

Cultivar	total dry matter	rF dry matter	sugars	vitamin C	carote-noids	K	Ca	Mg	Na
	%	°Bg	g · kg^{-1}	mg · kg^{-1} of f.m.					
green fruits									
Andrea	8	5	31.5	1622	96	2122	72	148	34
Beros	16	10	44.3	2174	235	2590	54	147	34
Eva	8	5	28.7	1575	112	2577	58	159	58
Granova	7	5	25.6	1501	118	2204	65	173	31
Jova	7	6	27.0	1701	132	2649	78	135	33
Karkulka	15	7	31.8	1960	470	3397	64	172	34
Korál	20	8	34.5	1626	404	3563	82	173	44
Maryša	7	5	47.3	1507	150	1983	66	134	34
PCR	8	5	33.9	1679	149	2280	55	118	32
Rubinova	7	5	33.3	1558	150	2402	74	162	25
mean	10.3	5.8	34	1690	313	2577	66	156	36
red fruits									
Andrea	9	8	47.6	2187	300	2498	50	123	29
Beros	18	9	48.6	2285	605	2876	37	125	27
Eva	9	8	42.1	2132	213	2800	69	141	28
Granova	8	8	45.1	2173	471	2657	58	183	26
Jova	8	7	42.5	2255	603	3059	50	189	35
Karkulka	14	8	35.1	2426	1584	3309	72	145	30
Korál	23	10	35.3	1881	1243	4771	53	241	36
Maryša	9	7	50.7	1883	550	2575	52	172	27
PCR	10	8	45.4	2162	970	2818	82	179	42
Rubinova	8	7	37.3	2214	470	2331	63	175	29
mean	12	8.2	43	2133	757	2160	56	176	31
Cultivar effect	*	*	*	**	*	**	*	*	*
Year effect	*	*	ns	ns	*	ns	*	*	*
Harvest date effect	ns	ns	*	*	ns	*	ns *[a]	ns	*

Explanations: sugar content in fresh matter (f.m.), ns – not significant, * – significant, ** – highly significant, [a] – significance in red fruits only

The total carotenoids content was higher in red fruits, 'Korál' cv. reached the value of 1243 mg · kg^{-1} in red stage, but spicy 'Karkulka' cv. reached 1584 mg · kg^{-1}. Green fruits were in the range of 96 – 470 mg · kg^{-1}.

The highest content of vitamin C was found in green and red fruits 'Beros' cv. (2174 and 2285 mg · kg^{-1}, respectively). The harvest date influenced the content of vitamin C. A higher level was observed in the time of better climate conditions, especially at the higher sun radiation.

The potassium content was the highest in green and red fruits Korál cv. (3563 and 4771 mg · kg^{-1}). Red fruits 'Karkulka' cv. also reached the higher potassium content . Later harvest date contributes to the higher K level in peppers. Cultivar 'Korál' reached the highest calcium concentration (82 mg · kg^{-1}) in green fruits and PCR cv. in red ones. Calcium content decreased at the later harvest date. Magnesium content was the highest in green and red fruits of 'Korál' cv. (173 and 241 mg · kg^{-1}), but no effect of harvest date was found.

Content of sodium in green fruits ranged from 25 mg ('Granova' cv.) to 58 mg · kg^{-1} ('Eva' cv.). The range of 26 mg ('Granova' cv.) to 42 mg · kg^{-1} ('PCR' cv.) was found among red fruits.

DISCUSSION

Mean refractometric dry matter was higher in the red fruits, but harvest differences were not significant. Correlation to the total dry matter was confirmed and the obtained levels correspond to the data of Shi et al. (1999).

Glucose and fructose content was higher in the red fruits and was similar to the data provided by Kopec (1998). Spicy cv. 'Karkulka' was the richest of all the other cultivars. The analysed sugar levels increased during a season and positively correlated to the ripening of the fruits.

Carotenoids were found in quite a variable range in green fruits and also red peppers shown around 10-fold variability within the chosen cultivars. Red peppers had more than twice as high carotenoid content. Literature also presents significantly higher carotenoid content in red pepper fruits (Wall et al., 2001). The effect of harvest date was not confirmed; however, their biosynthesis largely depends on climate.

Vitamin C content differed between green and red fruits. The other group reached higher values according to the results of Frank et al (2001). The observed levels correspond to the published data (USDA, 2001). Different concentrations of vitamin C found during the harvest season were variable and no trend was determined in fruits with the same colour.

Potassium content in fruit depended on the ripeness stage. Ripening of fruits contributed to the increase of potassium levels. The range of K content corresponds to the data which were published by Bar-Tal et al (2001). A later harvest date corresponds to the higher potassium content, probably due to the higher accumulation of dry matter in fruits.

While calcium content in green fruits was 68 mg · kg^{-1} (USDA, 2001), red fruits showed a slightly lower mean concentration (56 mg · kg^{-1}), as published by El-Saied (1998). The Effect of harvest time on Ca content was not detected.

A highly variable sodium content ranged with high variability in green and red fruits. Red peppers reached lower values. Similar levels were published by Holland et al (1992). No content decreased during the growing season.

CONCLUSION

Cultivar is one of the most important factors influencing the nutritive value of pepper fruits. The effect of cultivar was significantly confirmed in all the analysed compounds. A high variability of total dry matter was detected among cultivars, while there was nearly a threefold difference of the analysed levels. Highly variable data showed the concentration of carotenoids, potassium and calcium in green peppers and concentration of refractometric dry matter, carotenoids and sodium in red peppers.

Cultivars 'Andrea', 'Granova' and 'Rubinova' were comparable by mean content of the analysed nutrients in green peppers. On the other hand, the best nutritive value was detected in fruits of cultivar 'Beros', which was closely comparable to the spicy cultivar 'Karkulka'.

The breeders and growers should be concered not only with the economical properties of cultivars, but they should follow their nutritive values also. This can be another possible way of how to gain the marketing advantage of their products.

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STRESZCZENIE

Papryka jest ważnym źródłem witaminy C, karotenoidów i innych składników odżywczych. Praca przedstawia wyniki analiz chemicznych owoców niektórych odmian papryki uprawianej w warunkach polowych. Porównywano skład owoców zielonych i czerwonych (w pełni dojrzałych) z dwóch terminów zbioru. Średnia zawartość analizowanych składników w świeżych owocach zielonych i dojrzałych (czerwonych) była następująca: sucha masa ogółem 11%, sucha masa oznaczona refraktometrycznie 6-8° Bg, cukry redukujące 34-43 g · kg^{-1}, karotenoidy ogółem 313-757 mg · kg^{-1}, wit. C 1690-2133 mg · kg^{-1}, K – 2370 mg · kg^{-1}, Ca – 61 mg · kg^{-1}, Mg – 166 mg · kg^{-1}, Na – 34 mg · kg^{-1}. Stwierdzono istotny wpływ odmiany na zawartość analizowanych składników. Wykazano także istotny wpływ dojrzałości zbiorczej owoców na większość analizowanych składników. Wpływ warunków w kolejnych latach uprawy papryki i termin zbioru owoców na zawartość badanych składników był istotnie zróżnicowany.