OPEN ACCESS Potravinarstvo® Scientific Journal for Food Industry

Potravinarstvo, vol. 9, 2015, no. 1, p. 119-123
doi:10.5219/449
Received: 24 February 2015. Accepted: 28 March 2015.
Available online: 25 May 2015 at www.potravinarstvo.com

ISSN 1337-0960 (online)

QUALITATIVE AND QUANTITATIVE CHARACTERISTICS OF SERBIAN TOMATO VARIETIES GROWN IN CONDITIONS OF SLOVAK REPUBLIC

Alena Andrejiová, Alžbeta Hegedűsová, Ivana Mezeyová, Miroslav Marták, Miroslav Šlosár

ABSTRACT

The aim of submitted article was to estimate qualitative and quantitative characteristic of Serbian tomato varieties grown in conditions of Slovak republic and to compare the results with control tomato variety and evaluate their potential for the Slovak market. There were included 6 Serbian tomato varieties: ´Fantom VFCTm F1´, ´Marathon ASVF F1´, ´Honey Heart VF F1´, ´Uragan SVF F1´, ´Kazanova F1 VF´, ´Dinka F1´ and ´Tornado F1´ in control variant, which is wide spread in Slovak tomato production. As qualitative characteristic for every variety total yields (in kg) per every plant, total number of harvested fruits (in pieces for each plant) and average weight of one fruit in kg were evaluated. In Department of vegetable growing laboratory qualitative characteristics in case of all chosen tomato varieties were estimated (included firmness of fruits, total carotenoids estimation, ascorbic acid estimation). Serbian varieties reached lower total yields per plant. From the ´fruit weight´ point of view they created more or less homogenous group of bigger and heavier fruits in comparison with ´Tornado F1´ and statistically significant homogenous group when focusing on total number of fruits per plant in comparison with ´Tornado F1´ variety. Differences between control variant and chosen Serbian varieties were even more considerable in case of qualitative characteristics, where ´Tornado F1´ reached the lowest values in case of all observed characteristics - firmness of fruits, total carotenoids and ascorbic acid content. According to increasing importance of antioxidants in human diet, all tested Serbian varieties appeared to be very interesting for Slovak consumers from following both qualitative and quantitative characteristics.

Keywords: tomatoes; carotenoids; ascorbic acid; yields; varieties

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) as a one of the worldwide most grown vegetable belongs to family Solanaceae. At the present the biggest tomato producers are China, India and USA **(FAOSTAT, 2014)**. In Slovak Republic, according to last statistical outputs from the 2013, tomatoes were the second most cultivated vegetables, grown on the total area of 2948 ha, which represented the production of 44913 t **(Merava, 2014)**. List of registered varieties **(UKSUP, 2014)** refers together 85 varieties of tomatoes, which are allowed in Slovak republic, and it involves 52 plunge (indeterminate) and 33 bush (determinate) tomato varieties. Recommended dose for 1 person is 16 kg per year **(Kona and Konova, 2008),** whereby according to **(Merava, 2014)** in SR during the 2012 it was 18 kg/person, with the highest consumption of tomatoes (17. 8%) within the frame of the total vegetable consumption in Slovak republic. Tomato (*Lycopersicon esculentum*) is one of the major vegetable crops in Serbia **Milijasevic et al., (2009)**. According to comparative analyses of **Novakovic et al., (2012)** when comparing tomato indicators in Serbia, tomato were grown on area 20647 ha, with yields 8.7 t/ha and production 178823 t (values are presented as an average of the interval from 2001 till 2010).

Tomatoes are consumed raw, but also thermal processed, especially in Mediterranean, Greek, Italian, Southeast Asian, and East European cuisine, with increased interest in its nutrient value during the last three decades. The main reason is due to the presence of different antioxidant molecules such as carotenoids, ascorbic acid, vitamin E and phenol compounds, particularly flavonoids **Frusciante et al., (2007),** and lycopene, the main carotenoid in tomato **Yoshida et al., (2011)**. Tomato had all-trans-lycopene (1046-1099 μg/g Dry Weight (DW)), cis-lycopene (125-132 μg/g DW) and all-trans-beta-carotene (45-59 μg/g DW) as principal carotenoids. Tomato pulp and ketchup had all-trans-lycopene (951-999 μg/g DW and 455-476 μg/g DW), all-trans- -carotene (76-88 DW μg/g and 20-27 DW μg/g) and cis-lycopene (71-83 μg/g DW and 14-25 μg/g DW) as the main pigments, respectively. They also contained other carotenoids in much smaller amounts (lycoxanthin, zeaxanthin, anteraxanthin, lutein, gama-carotene, and phytofluene) **Gama et al., (2006)**. According to various authors, the total carotenoids content as well as lycopene in fresh tomato fruits depends mainly on genotypes **(Mendelová et al. 2015, Mendelová et al. 2013, and Carli et al. 2011)**. The big advantage of lycopene is its stability within the frame of various thermal processes. Processed tomato products like tomato juice, tomato paste, tomato puree, and tomato ketchup and tomato oleoresin have been shown to provide bioavailable sources of lycopene **Basu et al. (2007)**. Tomatoes are the richest source of lycopene in the Western diet **(Burton,**

Freeman and Sesso, 2014) and they are consumed like a functional food all over the world because of health promoting compounds in its fruit. Latest research highlights the relationship between consuming tomato and its products with reduced risk of various maladies like obesity, hyperglycemic and hypercholesterolemic attributes, cardiovascular disorders and cancer insurgences **(Perveen, 2015)**. Lycopene absorption is strongly impacted by dietary composition, especially the amount of fat. Concentrations of circulating lycopene in lipoproteins may be further influenced by a number of variations in genes related to lipid absorption and metabolism. Better understanding of the relationship between diet, genetics, and lycopene distribution will provide necessary information to interpret epidemiological findings more accurately **Moran et al., (2013)**. The fact remains, that increasing of carotenoids, lycopene, vitamin C and other antioxidants is requested and their content is one of the important parameter estimated in case of new varieties.

The aim of submitted article was to estimate qualitative and quantitative characteristic of six Serbian tomato varieties grown in conditions of Slovak republic and to compare the results with control tomato variety ´Tornado F1´ and evaluate their potential for the Slovak market.

MATERIAL AND METHODOLOGY

An experiment was founded in 2014 in Botanical Garden of Slovak University of Agriculture (below BG SUA) in tunnel conditions. Area is situated in very warm agro-climatic region, very dry sub-region. The average annual temperature is 10 °C. There were included 6 Serbian tomato varieties: ´Fantom VFCTm F1´, ´Marathon ASVF F1´, ´Honey Heart VF F1´, ´Uragan SVF F1´, ´Kazanova F1 VF´, ´Dinka F1´ and one Czech tomato variety: ´Tornado F1´ in control variant. Variety used in control variant is extended on Slovak market, and growers have good experiences with its production in our conditions. All chosen varieties are indeterminate. For these kinds of tomatoes it is characteristic flourishing stem with indeterminate growth. The plants are usually very high and they are grown with the prop, with systematic removing of side shoots. They support lot of handmade that is the reason for their extensive growing in tunnels **Uher et al., (2012)**. Vegetables were planted out in heatless tunnel in April 7th, 2014 in the united scale 0.7 x 0.5 m. For every variety there was planted 8 pieces of plants. After reaching phenological stage - ripening, fruits were gradually harvested from the beginning of July till middle of October, 2014.

Quantitative characteristics

For every variety total yields (in kg) per every plant, total number of harvested fruits (in pieces for each plant) and average weight of 1 fruit in kg were evaluated. Average volumes from each harvest were counted and statistically analyzed.

Qualitative characteristic

Following quantity in chosen tomato varieties, the qualitative characteristics were estimated in laboratory of Department of vegetable growing, SUA, in Nitra involving:

Firmness of fruits - Within all 7 observed varieties were measured ten replicates of firmness by penetrometer. The average volumes were evaluated.

Total carotenoids estimation - Carotenoids were estimated by spectrophotometric measurement of substances absorbance in petroleum ether extract on spectrophotometer PHARO 100 at 445 nm wavelengths. As an extraction reagent there was used acetone.

Ascorbic acid estimation - HPLC method of vitamin C content estimation was used for its quantity estimation by the help of liquid chromatograph with UV detector, for separation was used RP C18 column, mobile phase was methanol : water (5:95, v/v), UV detection was adjusted to 258 nm (HPLC fy. VARIAN).

Statistical analysis

The analysis of variance (ANOVA), the multifactor analysis of variance (MANOVA) and the multiple Range test were done using the Statgraphic Centurion XVII (StatPoint Inc. USA).

RESULTS AND DISCUSSION

Quantitative characteristic

According to submitted methods, there were evaluated total yields (kg), total number of harvested fruits (pieces) per one plant and average weight of 1 fruit in kg from each harvest (table 1).

In case of observed characteristic ´total number of fruits´ all Serbian varieties was classified in homogenous group from 22.75 ±2.92 (´Fantom VFCTm F1´) to 44.00 ±9.80 pieces per plant (´Dinka´), whereby ´Tornado F1´ created much more higher amount of fruits (104.63 ±12.39 pieces per plant). It corresponded with statistical analyzes, where it was determined statistically significant difference only between ´Tornado F1´ vs. all Serbian tomato varieties at 99.9% by Tukey test. Similar parameters were evaluated as a part of research of two tomato cultivars (´Cedrico´ and ´Abellus´) in polytunnels in Serbia **Savic et al., (2011)**. Their results with the values 40.45 number of fruits per plant and 5.52 kg per plant in case of ´Cedrico´ and the values 35.30 number of fruits per plant and 4.10 kg per plant for ´Abellus´ were comparable to Serbian varieties observed in our trial.

In opposite to high amount of fruits, following the characteristic ´average weight of one fruit´ the ´Tornado F1´ variety produced the most light – weighted fruits (0.07 ±0.02 kg) in comparison with other varieties. Fruits of Serbian varieties reached the values between 0.13 ±0.02 kg in case of ´Fantom VFCTm F1´ and 0.21 ±0.04 kg in ´Dinka F1´.

Qualitative characteristics

In Department of vegetable growing laboratory qualitative characteristics in case of all chosen tomato varieties were estimated (Table 2). The firmness of fruit was counted as an average from 10 measurements from each variety. The hardest fruits were confirmed for ´Honey Heart VF F1´ (firmness of fruit = 8.36 N), followed by ´Fantom VFCTm F1´ (8.07 N). In comparison with control variant represented by ´Tornado F1´ with firmness 5.25 N, all Serbian varieties had harder fruits.

Followed total carotenoids content estimated and represented in Figure 1 variety ´Kazanova F1 VF´ with values 13.07 mg/100g represented the upper limit of interval. Control variety ´Tornado F1´ enclosed the interval on the bottom limit with 4.71 mg/100g. In case of all Serbian varieties the higher content of carotenoids was confirmed in comparison with ´Tornado F1´. **Carli et al., (2011)** monitored the content of carotenoids in 7 varieties of tomatoes rand report their content from 3.63 to 17.5 mg/100g. In similar experiment which have included following tomato varieties: Bambino F1, Milica F1, (indeterminate tomato varieties) and Darina F1, Diana F1, Denar, Milica F1, Orange F1, Paulina F1, Šejk F1 (determinate tomato varieties), the carotenoid content in fresh fruits of selected varieties ranged from 2.63 to 6.55 mg/100g. The highest content of carotenoids was observed at variety Milica F1 and the lowest in Paulina F1 **Mendelova et al., (2013)**. All Serbian varieties except of ´Dinka F1´ (with 4.46 mg/100g for total carotenoids) had also higher amounts of observed compounds when comparing with the experiment of Mendelova. In comparison with other experiment, led by **Mendelova et al. (2010)**, where the content of carotenoids in fruits of tomatoes for industrial processing varied in the amount of 4.41 to 7.85 mg/100 g, the Serbian varieties ´Kazanova F1 VF´ and ´Fantom VFCTm F1´ reached bigger content of carotenoids, and others varieties belonged to higher limits of Mendelova´s interval. The content of carotenoids in the moniotred varieties decreased in the order: ´Kazanova F1 VF ´ > ´Fantom VFCTm F1´ > ´Marathon ASVF F1´ > ´Honey Heart VF F1´ > ´Uragan SVF F1´ > ´Dinka F1´ > ´Tornado F1´. Ascorbic acid content was ranged in interval from 11.51 mg/100g (´Tornado F1´) to 18.72 mg/100g (´Uragan SVF F1´). Similar, as it was providing other observed qualitative characteristics, all Serbian varieties reached higher content of vitamin C. George et al., (2004) indicate the content of ascorbic acid in tomato pulp from 8.4 to 32.4 mg/100 g. Substantial amounts of ascorbic acid were also detected in peels (9.0–56.0 mg/100 g fwb and 104–462 mg/100 g dwb). The content of ascorbic acid in the monitored varieties decreased in the order: ´Uragan SVF F1´ > ´Marathon ASVF F1´ > ´Honey Heart VF F1´ > ´Dinka F1´ > ´Fantom VFCTm F1´ > ´Kazanova F1 VF ´ > ´Tornado F1´.

Table 1 Chosen quantitative characteristic of observed tomato varieties grown in tunnel, in BG, SPU, Nitra, in 2014*.

Variety	total yields (kg/ 1 plant)	total number of fruits (pieces/ 1 plant)	average weight of 1 fruit (kg)
´Marathon ASVF F1´	7.50 ±1.40^{bc}	42.33 ±10.88^{a}	0.18 ±0.03^{bc}
´Fantom VFCTm F1´	3.05 ±0.70^{a}	22.75 ±2.92^{a}	0.13 ±0.02^{ab}
´Dinka F1´	8.93 ±0.56^{c}	44.00 ±9.80^{a}	0.21 ±0.04^{c}
´Tornado F1´	7.35 ±2.20^{bc}	104.63 ±12.386^{b}	0.07 ±0.02^{a}
´Uragan SVF F1´	5.62 ±1.52^{ab}	31.14 ±9.72^{a}	0.19 ±0.05^{bc}
´Honey Heart VF F1´	6.60 ±0.93^{bc}	32.33 ±9.86^{a}	0.21 ±0.07^{bc}
´Kazanova F1 VF´	3.21 ±0.93^{a}	20.89 ±2.86^{a}	0.14 ±0.03^{abc}

*Mean ±standard deviation.
Column values with different lowercase letters in superscript are significantly different at p <0.001 by Tukey HSD in ANOVA (Statgraphic)

Table 2 Chosen qualitative characteristic of observed tomato varieties grown in tunnel, in BG, SPU, Nitra, in 2014*

Variety	firmness (N)	total carotenoids (mg/100g)	vitamin C (mg/100g)
´Tornado F1´	5.25 ±0.79^{a}	4.71 ±0.57^{a}	11.51 ±0.86^{a}
´Fantom VFCTm F1´	8.07 ±0.54^{b}	9.79 ±0.57^{d}	12.08 ±0.26^{a}
´Marathon ASVF F1´	6.51 ±0.66^{a}	7.61 ±0.43^{c}	15.39 ±0.56^{b}
´Honey Heart VF F1´	8.36 ±0.78^{b}	6.95 ±0.15^{bc}	15.03 ±0.54^{b}
´Uragan SVF F1´	6.37 ±0.81^{a}	6.62 ±0.60^{abc}	18.72 ±0.76^{c}
´Kazanova F1 VF´	7.87 ±0.87^{b}	13.07 ±0.23^{e}	12.03 ±0.75^{a}
´Dinka F1´	5.47 ±0.61^{a}	5.46 ±0.73^{ab}	13.76 ±0.25^{ab}

*Mean ±standard deviation.
Column values with different lowercase letters in superscript are significantly different at p <0.001 by Tukey HSD in ANOVA (Statgraphic)

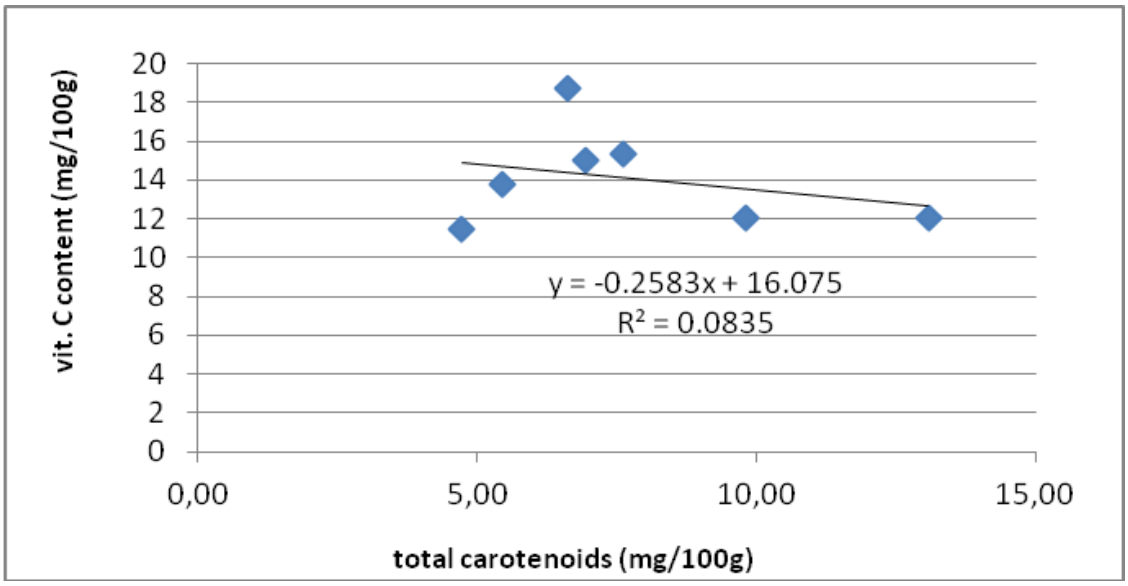

Figure 1 Ascorbic acid (vitamin C) content in chosen tomato varieties grown in tunnel, in BG, SPU, Nitra, in 2014.

According to wider spectrum of varieties, the correlation analyzes between vitamin C and carotenoid was done. Those two antioxidants are connected in some scientific studies with effort to find some relationships. It should be noted, that the usually close correlation between intake of vitamin C and carotenoids precludes any firms conclusions regarding to separate effects of dietary vitamin C and carotenoids on bladder cancer protection. In other words it is unclear if the observed dietary protective effect is due to carotenoids alone, vitamin C alone, or both **(Vogelzang, 2006)**. No correlation was obtained with any of the antioxidant constituents such as vitamin C and carotenoids **(Gil, 2002)**. The results corresponding with our findings figured in correlation on Figure 1.

CONCLUSION

The changes of quantitative and qualitative characteristics in dependence on chosen tomato varieties were estimated in the article. Differences between control variant and chosen Serbian varieties were founded in case of quantitative, but even more in case of qualitative characteristics, where ´Tornado F1´ reached the lowest values in all observed characteristics - firmness of fruits, total carotenoids and ascorbic acid content. According to increasing importance of antioxidants in human diet, all tested Serbian varieties appeared to be very interesting for Slovak consumers. From quantitative point of view, the control variety ´Tornado F1´ had the smallest fruits, whereby the values of Serbian varieties ranged in interval from 134 to 211 g. At the present on the Slovak market varieties with fruit weight in interval from 100 to 160 g are wide-spread used. Observed Serbian varieties create markedly bigger fruits in smaller amount, but they are noted for great gustative properties. On the base of complex evaluation, Serbian varieties are suitable previously to smaller growers for self-subsistent farming according to our recommendations.

REFERENCES

Basu, A., Imrhan, V. 2007. Tomatoes versus lycopene in oxidative stress and carcinogenesis: conclusions from clinical trials. *European Journal of Clinical Nutrition*, vol. 61, p. 295-303. http://dx.doi.org/10.1038/sj.ejcn.1602510

Burton-Freeman, B., Sesso, H. 2014. Whole food versus supplement: comparing the clinical evidence of tomato intake and lycopene supplementation on cardiovascular risk factors. *Adv. Nutr.*, vol. 5, p. 457-485. http://dx.doi.org/10.3945/an.114.005231

Carli, P., Caruso, G., Fogliano, V., Carputo, D., Frusciante, L., Ercolano, M. R. 2011. Development of a methodology to forecast the nutritional value of new tomato hybrids. *Euphytica*, vol. 180, no 3, p. 291-300. http://dx.doi.org/10.1007/s10681-011-0350-0

Ece, A., Darakci, N. 2007. Determination of Relationships Between Number of Stem and Yield of Tomato (*Lycopersicon lycopersicum* L.). *Asian Journal of Plant Sciences*, vol. 6, no. 5, p. 802-808. http://dx.doi.org/10.3923/ajps.2007.802.808

Food and Agriculture Organization of the United Nations (FAOSTAT) 2014. [cit. 2014-12-10]. Available at: http://faostat.fao.org/site/339/default.aspx

Frusciante, L., Carli, P., Ercolano, M. R., Pernice, R., Di Matteo, A., Fogliano, V., Pellegrini, N. 2007. Antioxidant nutritional quality of tomato. *Mol. Nutr. Food Res.*, vol. 51, no 5, p. 609-617. http://dx.doi.org/10.1002/mnfr.200600158 PMid:17427261

Gama, J. J. T., Tadiotti, A. C., Sylos, C. M. 2006. Comparison of carotenoid content in tomato, tomato pulp and ketchup by liquid chromatography, *Alim. Nutr.*, vol. 17, no. 4, p. 353-358. [cit. 2014-02-10] Available at: http://serv-bib.fcfar.unesp.br/seer/index.php/alimentos/article/viewFile/285/278

Georgea, B., Kaura, Ch., Khurdiyaa, D. S., Kapoorb, H. C. 2004. Antioxidants in tomato (*Lycopersium esculentum*) as a function of genotype. *Food Chemistry*, vol. 84, no. 1, p. 45-51. http://dx.doi.org/10.1016/S0308-8146(03)00165-1

Gil, M. I., Tomas-Barberan, F. A. N, Hess-Pierce, B., Kader, A. A. 2002. Antioxidant capacities, phenolic compounds, carotenoids, and vitamin C contents of nectarine, peach, and plum cultivars from California, *J. Agric. Food*

Chem., vol. 50, no. 17, p. 4976-4982. http://dx.doi.org/10.1021/jf020136b PMid:12166993

Kona, J., Konova, E. 2008. Rajčiak jedlý: *Lycopersicon esculentum Mill.*, Nitra: Garmond, 2008, 93 p. ISBN 978-80-89148-46-2

Mendelova, A., Fikselova, M., Mendel, L. 2013. Carotenoids and lycopene content in fresh and dried tomato fruits and tomato juice. *Acta Univ. Agric. Silvic. Mendelianae Brun.*, vol. 61, no. 5, p. 1329-1337. http://dx.doi.org/10.11118/actaun201361051329

Mendelova, A., Fikselova, M., Mendel, L., Andrejiova, A., Marecek, J., Czako, P. 2015. Quality assessment of edible tomato varieties intended for industrial processing, *Journal of Microbiology, Biotechnology and Food Sciences*, vol. 4, no. 3, p. 114-117. [cit. 2014-12-15] Available at: http://www.jmbfs.org/wp-content/uploads/2015/02/Mendelova.pdf

Mendelova, A., Marecek, J., Vietoris, V. 2010. Dynamics of carotenoids and lycopene content in fruits of tomato (Lycopersicon esculentumMill.). *Potravinarstvo*, vol. 4, p. 82-86. [cit. 2014-12-15] Available at: http://www.potravinarstvo.com/dokumenty/mc_februar_2010/pdf/1/Mendelova.pdf

Meravá, E. 2014. Vegetables. Situation and outlook report. *National Agricultural and Food Centre Branch: Research Institute of Agriculture and Food*, VÚEPP Bratislava, 2014, 50 p. ISSN 1338-8010.

Milijašević, S., Todorović, B., Rekanović, E., Potočnik, I., Gavrilović, V. 2009. Races and hosts of Pseudomonas syringae pv. tomato in Serbia. *Arch. Biol. Sci.. Belgrade*., vol. 61, no. 1, p. 93-102. http://dx.doi.org/10.2298/ABS0901093M

Moran, N. E., Erdman, J. W. jr., Clinton, S. K.2013. Complex interactions between dietary and genetic factors impact lycopene metabolism and distribution. *Arch. Biochem. Biophys*. vol. 539, no. 2, p. 171-180. http://dx.doi.org/10.1016/j.abb.2013.06.017 PMid:23845854

Novakovic, N., Mutavdzic, B., Ivanisevic, D., Ilin, Z. 2012. Comparative analysis of vegetables production in Serbia and republic of Srpska, *Third International Scientific Symposium "Agrosym Jahorina 2012"*., p. 650-655 [cit. 2014-12-15] Available at: http://78.28.152.12/agrosym/agrosym_2012/dokumenti/5_ruralni_razvoj/13_RD_Novakovic_Nebojsa.pdf

Perveen, A. R., Suleria, H. A. R., Anjum, F. M., Butt, M. S., Pasha, I., Ahmad, S. 2015. Tomato (*Solanum lycopersicum*) carotenoids & lycopenes chemistry; Metabolism. Absorption. Nutrition and Allied health claims - A comprehensive review. *Crit. Rev. Food Sci. Nutr*., vol. 55, no. 7, p. 919-929, http://dx.doi.org/10.1080/10408398.2012.657809 PMid:24915375

Savic, S., Stikic, R., Zaric, V., Vucelic-Radovic, B., Jovanovic, Z., Marjanovic, M., Djordjevic, S., Petkovic, D. 2011. Deficit irrigation technique for reducing water use of tomato under polytunnel conditions. *Journal of Central European Agriculture*. vol. 12, no. 4, p. 590-600. http://dx.doi.org/10.5513/JCEA01/12.4.960

Uher, A., Andreijová, A., Bernáth, S., Černý, I., Kóňa, J., Mezey, J., Paulen, O., Valšíková, M. 2012. *Poľné a záhradné plodiny* (*Field and garden crops*). SPU. 305 p. ISBN: 9788055208244

UKSUP (Ustredný kontrolný a skúšobný ústav potravinársky) - Central and Testing Institute in Agriculture, 2014. List of registered varieties for Slovak republic, 2014. Central and Testing Institute in Agriculture. [cit. 2014-12-10] Available at: http://www.uksup.sk/download/odrody/20140109_LRO_2013.pdf

Vogelzang, N. 2006. *Comprehensive Textbook of Genitourinary Oncology*. Philadelphia, USA: Lippincott Williams & Wilkins, 2006, 907 p. ISBN: 0781749840.

Yoshida, K., Yokoyama, H., Oteki, T., Matsumoto, G., Aizawa, K., Inakuma, T. 2011. Evaluation of the effect of dietary lycopene, the main carotenoid in tomato (*Lycopersicon esculentum*), on the *in vivo* renal reducing ability by a radiofrequency electron paramagnetic resonance method.: *J. Agric. Food Chem*. vol. 59, no. 7, p. 2966-2971. http://dx.doi.org/10.1021/jf1041883 PMid:21381743

Acknowledgment:

The work was supported by VEGA project No. 1/0105/14 and KEGA project 038SPU-4/2014.

Contact address:

Ing. Alena Andrejiová, PhD., Slovak University of Agriculture in Nitra, Horticulture and Landscape Engineering Faculty, Department of Vegetable Production, Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic, E-mail: alena.andrejiova@uniag.sk.

prof. RNDr. Alžbeta Hegedűsová, PhD., Slovak University of Agriculture in Nitra, Horticulture and Landscape Engineering Faculty, Department of Vegetable Production, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia, E-mail: alzbeta.hegedusova@uniag.sk.

Ing. Ivana Mezeyová, PhD., Slovak University of Agriculture in Nitra, Horticulture and Landscape Engineering Faculty, Department of Vegetable Production, Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic, E-mail: ivana.mezeyova@uniag.sk.

Ing. Miroslav Šlosár, PhD., Slovak University of Agriculture in Nitra, Horticulture and Landscape Engineering Faculty, Department of Vegetable Production, Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic, E-mail: miroslav.slosar@uniag.sk.

Bc. Miroslav Marták, Slovak University of Agriculture in Nitra, Horticulture and Landscape Engineering Faculty, Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic, E-mail: martak.miroslav@azet.sk.