DOI: 10.34101/ACTAAGRAR/1/8422

Effect of harvesting time on the vitamin C content and yield of chili pepper

Clarice Silva e Souza[1*] – Stella Agyemang Duah[1] – Zoltán Pék[1] – Szilvia Ráth[1] – Lajos Helyes[1] – Hussein Daood[1]

[1]Szent István University, Gödöllő, Hungary
*****Correspondence: clarice.souza@phd.uni-szie.hu

SUMMARY

For thousands of years, chili pepper has been used in cooking intensifying the aroma, colouring, and even flavouring with its pungency. Today, it is also of interest for the various food and pharmaceutical industries due to its intrinsic characteristics. These characteristics of pepper and its yield can be affected by both the variety and the temperature fluctuation throughout the harvest period. The current work's objective was to investigate the effect of harvest time on vitamin C of different varieties of chili pepper C. frutescens and C. annuum cultivated in Hungary, as well as the yield of pepper in different harvesting periods. Vitamin C was determined by HPLC protocols. The differences between harvest times and varieties were analysed using Tukey post hoc test at 5%. All varieties showed fluctuation of vitamin C level, depending on the given harvest date. At the last harvest, all varieties had higher vitamin C content. All varieties had the same yield trend throughout the year but with different yields between each. Variety Heténi Parázs had the highest vitamin C content and yield: 3720.53 µg g^{-1} vitamin C and 18.63 t ha^{-1} average yield, respectively.

Keywords: *Capsicum sp.; HPLC; in nature; open field*

INTRODUCTION

Chili pepper is among the most used spices in world's cuisine. It gives pungency, aroma and color to foods. Usage of chili pepper in cuisine is not the sole application of this plant, due to the presence of nutritional compounds and their benefit for consumers. Food industries are interested in pepper's raw material for foods as potential ingredients, thereby giving a different flavor of their products (sausages, soups, sauces, snacks) (Baenas et al., 2018). The cosmetic and pharmaceutical industries are applying raw materials or plant extracts as natural components for use in pharmaceutical and cosmetic applications using natural bioactive compounds for improving the quality of Their products (Baenas et al., 2018) and for the colouring of cosmetics (EFSA, 2015; FDA, 2017).

Human body does not synthetise vitamin C, i.e. humans needs to consume it. The benefits of vitamin C are diverse, and when it is in balanced amounts in our body, it participates in different important metabolic activities. The main function of vitamin C lies in its antioxidant activity: fighting against free radicals and regenerating other antioxidants (Mastrangelo et al., 2017). Vitamin C can help in the absorption of different minerals (iron, calcium, folic acid) too, preventing cancer and maintain the function of enzymes (Mastrangelo et al., 2017). Vitamin C deficiency may even lead to neurodegenerative diseases and psychiatric disorders. Vitamin C is the most common vitamin in different varieties of chili peppers (Kumar and Tata, 2019).

Chili fruits reach their complete ripened state at different periods during the year. It is essential to know the differences in the characteristic of the fruits from different harvests. High temperature stress can affect chili yield, shape, diameter, weight, and number of fruits (Gunawardena and De Silva, 2014). Analysing the vitamin C content and yield of different harvests allows us to understand the monthly, seasonal, and annual trends related to abiotic factors, that can influence pepper production and quality.

The aim of this study was the examination the effect of harvest period on the vitamin C and the yield of field grown chili pepper.

MATERIALS AND METHODS

Experimental area and yield

The study was carried out at Gödöllő, Hungary (latitude 47°61′ N, long. 19°32′ E), where there is around 560 mm of yearly precipitation, at the Horticulture Institute Experimental Field of the Hungarian University of Agriculture and Life Sciences. The described soil texture was sandy-loam, mostly cambisols with 65% of sand, 8% of clay, 27% of silt fraction, and 1.6% organic matter. At a depth of around 35 cm of the top layer, the soil had a pH of 7.9, 16% field capacity, and a density of 1.54 g m^{-3}. The seeds from the cultivars 'Heténi Parázs' (HET), 'Unikal' (UNIK), 'Unijol' (UNIJ), and Habanero (HAB) was leading from Univer Product Zrt, food industry in Hungary provides the seeds.

On May 16th, 2019, the seedlings were delivered for open field cultivation after a total of 40 days of germination in a nursery. Three (3) different water supply treatments were used during the experimental work, including; 0% (control except for natural precipitation), 50% deficit irrigation and 100% optimum water supply. The seedlings were cultivated in twin rows with 0.25 m spacing inside the rows and 0.25 m between plants in a row, with a plant density of 6.66 plants m^{-2} for HET and UNIK. In the case of UNIJ and HAB, the seedlings had a different space between them being of 0.5 m inside the rows and 0.5 m between plants in a row, with a plant density of 3.33 plants m^{-2}. For all cultivars, the distance between the adjacent twin rows was 0.75 m in 2018 and 1.5 m in 2019. The

DOI: 10.34101/ACTAAGRAR/1/8422

adjusted spacing between twin rows in 2019 was purposely done to manage weed growth easily. The entire experiment was set up on a one-hectare area of land using a randomised complete block design (RCBD), with four repetitions or blocks per treatment.

The first harvest was performed on 12th of August, the second on 2nd of October, the third on 7th of October and the final on the 24th of October. Completely ripened chili fruits were collected in case of each harvest.

Fifteen fruits within 24 hours after the collection were selected used and from each replication for vitamin C analyses.

Vitamin C assay: 5 g fresh chili pepper was homogenised with quartz sand and 50 ml of 3% metaphosphoric acid. The solution was transferred into a 100 mL Erlenmeyer flask and was ultrasonicated for about 5 minutes. After it was shaked for 15 minutes in the rotation shaker. The samples then were filtrated with filter paper and further purified by passing it through a 0.45 µm polytetrafluoroetylene (PTFE) filter before injection into a high-performance liquid chromatography (HPLC) column. The analysis was performed according to the protocols and methods of Nagy et al. (2015).

The HPLC system (Hitachi Chromaster, Japan) included a gradient pump (Model 5110 Pump), an automatic injector (Model 5210 Auto Sampler), a diode-array detector (Model 5430 Diode Array), a fluorescent detector (Model Fluorescens), and a column thermostat (Jetstream). The highest absorption of vitamin C was detected at 265 nm. The evaluation of the chromatograms was carried out by the software EZChrome Elite, using standard materials obtained from Sigma-Aldrich (Budapest, Hungary).

Yield measurement: The fruit weight was measured using a weighing scale of 0.01 g precision and average yield was calculated (t ha^{-1}). Cultivation was done on a one-hectare plot of land, with 6.66 plant m^{-2} for Heténi Parázs and Unikal and 3.33 plant m^{-2} for Unijol and Habanero.

RESULTS AND DISCUSSION

There were differences between the different period of harvests and the concentration of the vitamin C present in the chili (*Table 1*). For all harvest Heténi Parázs and Unikal present at higher concentrations of vitamin C.

Table 1: **Vitamin C content of the examined varieties at different harvests (µg g^{-1})**

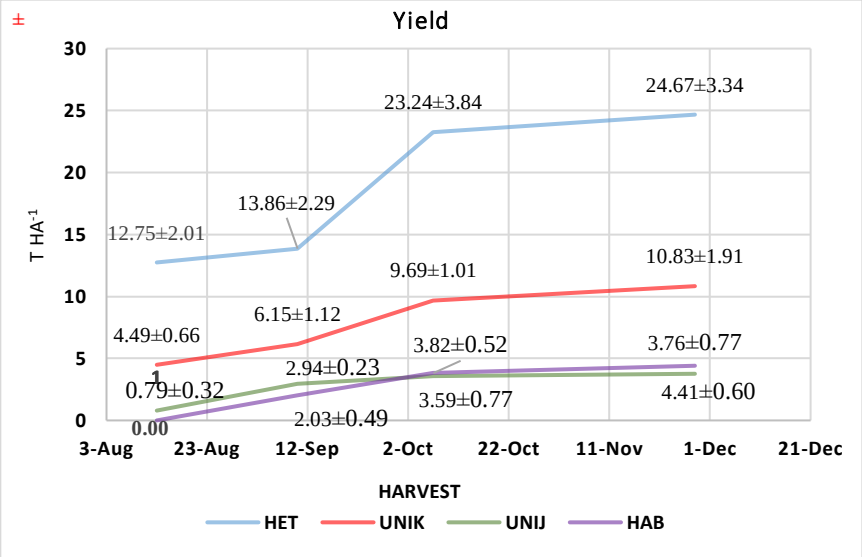
	Vitamin C (µg g^{-1})			
	Harvest 1	Harvest 2	Harvest 3	Harvest 4
Heténi Parázs	3725.19 b	3371.50 b	3387.93 c	4397.52 b
Unikal	3545.61 b	2320.30 a	2653.18 b	4183.99 b
Unijol	2615.95 a	1744.33 a	2646.61 b	3624.45 a
Habanero	–	1658.92 a	2136.34 a	3223.68 a

Means followed by the same letter on the column do not differ from each other according to Tukey test on the level of 5%

Table 1 shows the vitamin C content of examined varieties at different harvests. In the case of the first harvest, Habanero did not produce ripened fruits, so the vitamin C content of varieties Heténi Parázs, Unikal and Unijol, was measured only. Vitamin C content of all free varieties decreased by the second harvest. However, from the second harvest, the vitamin C content of all varieties increased and reached their maximum at the last harvest.

Chili pepper yield had similar trend in case of all varieties as shown in *Figure 2*. The first harvest had the lowest and the last harvest had the highest yield. However, there were differences amongst varieties. Heténi Parázs had the highest yield (average 18.63 t ha^{-1}). Unikal had lower (average 7.79 t ha^{-1}), and Unijol and Habanero had even lower yields, as shown in the *Figure 1*.

Figure 1: **Pepper yield (Heténi Parázs, Unikal, Unijol and Habanero) of harvest periods throughout the year 2019**



DOI: 10.34101/ACTAAGRAR/1/8422

The study shows that, for all harvest periods, the HeténYi Parázs have the highest amount of vitamin C, through this result we can interfere that it was the species that was least influenced by external factors for the production of vitamin C, but more studies should be carried out. On the other hand, the Habanero have the less production of vitamin C together with the Unijol.

Factors other than the time of harvest of course may also have influence on the production of vitamin C as demonstrated by the authors (Nagy et al., 2015 and Gnayfeed et al., 2001), as they found correlations between the production of vitamin C and the ripening stage and varieties. The better yield performances of the plants were Hetényi Parázs and Unikal, the agricultural production depends on edaphoclimatic factors that will affect production along with other factors such as plant genetics, region's climate, and planting such as soil type, planting density and cultural care.

CONCLUSIONS

This study shows that the kind of pepper and the time of harvest may affect the yield and the production of vitamin C. The concentration of vitamin C may be more related to the variety under study and specific type of environment, in the present study Hetényi Parázs constantly presents a higher concentration of vitamin C. For raw material of food industry or pharmaceutical production we suggest Hetényi Parázs that presented the highest production (t ha^{-1}) and highest vitamin C content.

ACKNOWLEDGEMENTS

The publication is supported by the EFOP3.6.3-VEKOP-16-2017-00008, GINOP-2.2.1-15-2016-00003 and EFOP-3.6.1-16-201600016 projects. These projects are co-financed by the Higher Education Institutional Excellence Program (NKFIH-1159-6/2019/FEKUTSTRAT) awarded by the Ministry for Innovation and Technology within the framework of the water-related research of Szent István University

REFERENCES (I put some DOI number, because those are necessaries, please check them)

Baenas, N.–Belović, M.–Ilic, N.–Moreno, D.A.–García-Viguera, C. (2019): Industrial use of pepper (*Capsicum annum* L.) derived products: Technological benefits and biological advantages. Food chemistry, 274, 872–885. DOI: https://doi.org/10.1016/j.foodchem.2018.09.047

EFSA ANS Panel (2015): Re-evaluation of paprika extract (E 160c) as a food additive. EFSA Journal 13(12), 4320. DOI: 10.2903/j.efsa.2015.4320

FDA. (2017): Cosmetic Ingredients. FDA database. Food and Drug Administration U.S. URL: https://www.fda.gov/Cosmetics/ProductsIngredients/Ingredients/default.htm; Accessed: 14 May 2020

Gnayfeed, M.H.–Daood, H.G.–Biacs, P.A.–Alcaraz, C.F. (2001): Content of bioactive compounds in pungent spice red pepper (paprika) as affected by ripening and genotype. Journal of the Science of Food and Agriculture, 81(15), 1580–1585. DOI: 10.1002/jsfa.982

Gunawardena, M.D.M.–De Silva, C.S. (2014): Identifying the impact of temperature and water stress on growth and yield parameters of chilli (*Capsicum annuum* L). OUSL Journal 7: 25–42. DOI: http://doi.org/10.4038/ouslj.v7i0.7306

Kumar, O.A.–Tata, S.S. (2009). Ascorbic acid contents in chili peppers (*Capsicum* L.). Notulae Scientia Biologicae, 1(1), 50–52. DOI: https://doi.org/10.15835/nsb113445

Mastrangelo, D.–Massai, L.–Fioritoni, G.–Coco, F.–L. (2017): Vitamin C against cancer. In: Hamza, A.H. Vitamin C, IntechOpen, DOI: 10.5772/intechopen.68746. URL: https://www.intechopen.com/books/vitamin-c/vitamin-c-against-cancer

Nagy, Z.–Daood, H.–Ambrózy, Z.–Helyes, L. (2015): Determination of polyphenols, capsaicinoids, and vitamin C in new hybrids of chili peppers. Journal of analytical methods in chemistry. 102125. DOI: 10.1155/2015/102125