Original article **UDC: 635.644-152.75:631.544]:577.164.2**
doi:10.5633/amm.2022.0104

DETERMINATION OF LYCOPENE CONTENT IN CULTIVARS OF *SOLANUM LICOPERSICUM* GROWN IN GREENHOUSE CONDITIONS

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Lycopene is carotenoid, the pigment responsible for the color of ripe tomato.

The aim of this study was to determinate and compare lycopene content in fresh tomato grown under greenhouse conditions in Serbia (cultivar Hector-F_1), North Macedonia (cultivar Hamzali-F_1), Greece (cultivar Optima-F_1) and Turkey (cultivar Benetar-F_1). For this purpose, spectrophotometric method was used. The highest lycopene content is found to be in tomato grown in Serbia, followed by Turkey, Greece and North Macedonia with values given mg/kg of fresh fruit 81.53, 76.33, 27.92 and 13.49 respectively. The results confirmed that fresh tomato is good source of lycopene.

Acta Medica Medianae 2022;61(1):30-35.

Key words: *lycopene, tomato, spectrophotometric method*

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Introduction

Lycopene is a substance classified as phytochemical, bright red colored, carotenoid pigment, which can be found in tomatoes and other red fruits such as watermelon, pink grapefruit, pink guava, red bell pepper, papaya. In an organism that has the ability of photosynthesis, such as plants, algae and others, it plays an important role as a mediator in biochemical reactions of many carotenoids. Thus, beta carotene is responsible for yellow, orange or red pigmentation. Because of its strong color and non-toxicity, lycopene has found usage as a food colorant (1).

Lycopene is a polyene hydrocarbon, actually an acyclic open-chain unsaturated carotenoid having 13 double bonds, with 11 conjugated double bonds that are arranged linearly. It has molecular formula C_{40} H_{56}. Two central methyl groups are placed in the 1, 6 position, while the remaining methyl groups are in the 1, 5 position by each other. A series of conjugated double bonds in structure forms a chromatophore of variable length. The color and antioxidant activities of lycopene are a consequence of its unique structure, an extended system of conjugated double bonds (2) (Figure 1).

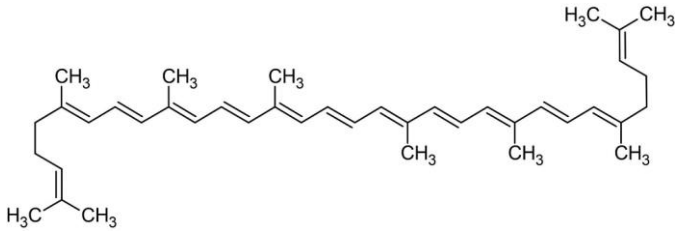

Figure 1. Structural formula of lycopene

Primary dietary source of lycopene in everyday nutrition is tomato and tomato based products (more than 80%) (3). Because of their composition, tomatoes and tomato based foods are considered as healthy food. They are low in fat and calories, cholesterol free and present a good source of fiber and protein. Also, tomatoes are rich in vitamins A, C, β-carotene, potassium, and lycopene. Well known red color of ripe tomato fruits and tomato based food products, which is considered as a measure of total quality, is due to lycopene (4). Some of the agricultural products that have high content of lycopene are: tomatoes, pink grapefruit, papaya and rosehip. The *Solanaceae* family consists of many species and its representative is *Lycopersicum esculentum* – tomato (5).

Lycopene is soluble in oils, so they help its absorption. Neither World Health Organization nor European Food Safety Authority gives recommendations for daily lycopene intake. Agarwal et al. in their work give recommendation for optimal daily intake of lycopene 3.35-4.82 mg (6). According to the work published by Uylaşer, daily intake of lycopene in amounts 5-7 mg is recommended for healthy humans in order to negate oxidative stress and for prevention of chronic diseases (7). Unlike some amino acids, lycopene is not an essential nutrient for humans. The intake of lycopene is through common diet, mostly from dishes with tomato sauce (8). Reduced risk of cancer is associated with daily intake of lycopene from food (9). Experimental researches showed that lycopene had high antioxidant activity and singlet oxygen quenching ability (10). It is obvious that it has properties which can improve human health and therefore deserves attention (7).

The aim

The aim of this work was to determinate and compare the lycopene content of fresh tomato of different species grown in Serbia, North Macedonia, Greece and Turkey (Figure 2).

Figure 2. Tomato cultivars grown in:
Serbia – Hector F_1; North Macedonia – Hamzali F_1, Greece – Optima F_1, Turkey – Benetar F_1

Materials and methods

Fruit material

For this experimental research tomato bought in April 2021 on the open market in Niš, Serbia was used. All species were cultivated in greenhouse, and their growth was observed. The tomatoes were washed, sliced and after that homogenized in Brown® blender.

Chemicals

Acetone was obtained from Fisher Scientific (Loughborough, United Kingdom), hexane, butylated hydroxytoluene and ethanol were purchased from Sigma-Aldrich (Steinheim, Germany).

Lycopene content determination

Spectrophotometrical method was used for total lycopene content determination as described (11). A 1 g of sample (fruit material) was added to a mixture consisting of 25 ml of hexane, 12.5 ml of acetone, 12.5 ml of ethanol and 0.05% (w/v) butylated hydroxytoluene. Afterwards, the mixture was stoppered and placed on an orbital shaker to mix at 180 rpm for 15 minutes (temperature of mixing was 5 ^{O}C). Process was followed with shaking, 7.5 ml of cold deionized water was added and the mixture was agitated for another 5 min. The suspension was left at room temperature for 10 minutes for separation of polar and non-polar layers to happen.

The absorbance of upper (non-polar) layer was mea-sured in a 1 cm path length glass cuvette at 503 nm versus a blank of hexane solvent on Jenway 6105 UV/Vis spectrophotometer (Jenway,

United Kingdom). Final calculation of the lycopene content was done using following equation:

$$A = \varepsilon\, b \cdot c$$

- (**ε**) the molar extinction coefficient of 17.2 x 10^4 M/cm is that reported (12),
- b is a 1 cm path length glass cuvette and c is concentration of lycopene.

All measurements were conducted in triplicate and data were expressed as mean values.

Results and Discussion

The lycopene content of the tomato fresh fruit grown in greenhouse conditions in the territory of Serbia, North Macedonia, Greece and Turkey was determined as follows: 81.53 mg/kg, 13.49 mg/kg, 27.92 mg/kg and 76.33 mg/kg in each examined cultivar respectively (Figures 3, 4).

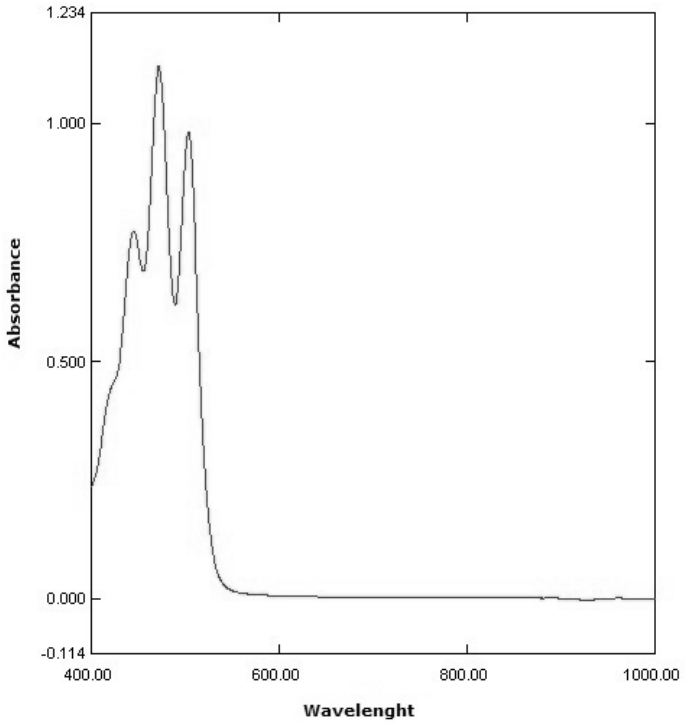

Figure 3. UV/VIS spectra of lycopene

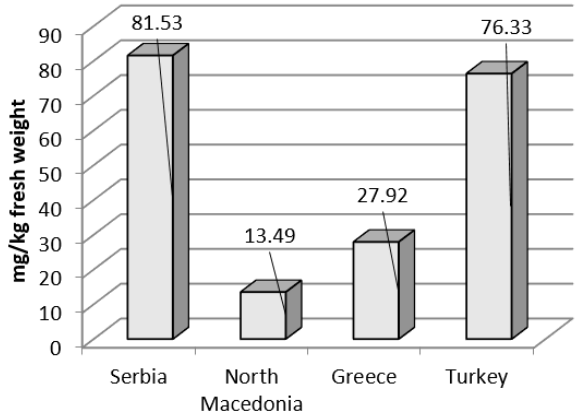

Figure 4. Lycopene content of tomato cultivated in greenhouse conditions in Serbia, North Macedonia, Greece and Turkey

It can be observed that there is a difference in lycopene content between cultivars. Hart and Scott reported that the amount of lycopene depended on variety, maturity and environmental conditions. They found that lycopene content in fresh raw tomato was 29.37 mg/kg and 37.03 mg/kg. Samples were kept frozen until the start of analysis and different composition of solvents was used (50 ml of tetrahydrofuran and methanol in ratio 1:1). These results were obtained by using HPLC with UV-VIS detector. For a reminder, UV-VIS method was used in our experimental research. However, cultivar conditions are not mentioned. Difference in results may be due to different cultivars which were analyzed (13). Gould researched how growing affected lycopene content of tomato. He showed that fruits grown in greenhouse during no matter what season (summer or winter) had lower lycopene content than fruits produced outdoors during summer time. Also, fruits picked up earlier and ripened during storage period are lower in lycopene content than ones that are fully ripened (14).

Results of our research are in agreement and very similar with the results for fresh tomato from Serbia. Veljović et al. calculated lycopene content in fresh tomato and found that fresh tomato had 79.66 mg/kg of fresh fruit (15). Jovanovski et al. Determined lycopene content in tomato growing in North Macedonia and it was 11.26 mg/dm^3 (16). Kapoulas et al. made a research about tomato cultivars Robin-F_1, Amati-F_1 and Elpida-F_1. The lycopene content was in range 24-37.5 mg/kg of fresh weight with the highest value for Elpida-F_1 cultivar (17). In the study by Karakaya and Yilmaz, the lycopene content of fresh tomatoes (cultivar Rio Grande) grown in Turkey was found to be 17.4 mg/kg (18).

Conclusion

We have reported results on lycopene content for tomatoes cultivated under greenhouse conditions in Serbia, North Macedonia, Greece and Turkey, determined using UV/Vis spectrophotometric method. Our results have shown lycopene content variation in different tomato cultivars grown in four diverse geographic locations. In our research, the highest lycopene content (81.53 mg/kg fresh fruit) was determined in tomato sample grown in Serbia. Results of our study are recommending fresh tomato as a good source of lycopene, where with everyday consumption the recommended daily intake can be easily achieved.

Acknowledgement

Funding of this work was provided by Republic of Serbia - Ministry of Education, Science and Technological Development, Program for financing scientific research work, number 451-03-9/2021-14/200133.

Vojkan Miljković wants to thank prof. dr Boris Đinđić for the inspiring conversation that led to this work.

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Originalni rad **UDC: 635.644-152.75:631.544]:577.164.2**
doi:10.5633/amm.2022.0104

ODREĐIVANJE SADRŽAJA LIKOPENA U SORTAMA *SOLANUM LICOPERSICUM* UZGAJANIM U PLASTENICIMA

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Likopen je karotenoid, pigment odgovoran za boju zrelog paradajza. Cilj ovog istraživanja je određivanje i upoređivanje sadržaja likopena u svežem paradajzu uzgajanom u uslovima plastenika u Srbiji (sorta Hector-F_1), Severnoj Makedoniji (Hamzali-F_1), Grčkoj (Optima-F_1) i Turskoj (Benetar-F_1). U tu svrhu, primenjena je spektrofotometrijska metoda. Najveći sadržaj likopena određen je u paradajzu uzgojenom u Srbiji, zatim u Turskoj, Grčkoj i Severnoj Makedoniji, sa vrednostima datim u jedinicama mg/kg svežeg paradajza 81,53, 76, 33, 27,92 i 13,49 respektivno. Rezultati su pokazali to da je svež paradajz dobar izvor likopena.

Acta Medica Medianae 2022;61(1):30-35.

Ključne reči: *likopen, paradajz, spektrofotometrijska metoda*