Tomato Ripeness Influence on Fruit Quality

A. Radzevičius, P. Viškelis, R. Karklelienė, J. Viškelis, Č. Bobinas, E. Dambruaskienė and S. Sakalauskienė

Abstract—Tomato nutrition value, color, flavor of their fruits and products depends mainly on lycopene, β-carotene, ascorbic acid, sugars and their ratio. The two most important carotenoids in fruits of tomato are lycopene, which determined fruits red color, and β-carotene, which accounts for approximately 7% of the tomato carotenoids. Therefore, tomato products and their quality can be well characterized by the content of these elements. Maturity at harvest is very important to composition and quality of tomatoes. This is especially a problem with tomatoes picked green since it is difficult to differentiate between mature and immature-green fruits. Typical and advanced mature-green tomatoes will usually attain a much better flavor than those picked at the immature or partially mature stages. To better understand the synthesis of biochemical compounds, their concentration should be compared not only at the last stage of maturity, but also during all fruit ripening period in different varieties.

Keywords—quality, ripeness, tomato, variety

I. INTRODUCTION

Tomato nutrition value, color, flavor of their fruits and products depends mainly on lycopene, β-carotene, ascorbic acid, sugars and their ratio. The two most important carotenoids in fruits of tomato are lycopene, which determined fruits red color, and β-carotene, which accounts for approximately 7% of the tomato carotenoids. Therefore, tomato products and their quality can be well characterized by the content of these elements [1].

Most of the research works describe tomato biochemical composition in the fully ripen fruits (in red tomato) at technical fruit maturity stage. To better understand the synthesis of carotenoids and other biochemical compounds, their concentration should be compared not only in red fruits, at the last stage of maturity, but also during all fruit ripening period (from green tomato fruit ripening stage to the technical fruit maturity) in different varieties. During tomato fruit ripening, carotenoids concentrations are changing constantly. It is related with chlorophyll degradation and carotenoids synthesis processes, when chloroplasts are synthesized in to the chromoplasts [2, 3].

Maturity at harvest is very important to composition and quality of tomatoes. This is especially a problem with tomatoes picked green since it is difficult to differentiate between mature and immature-green fruits. Typical and advanced mature-green tomatoes will usually attain a much better flavor at the table-ripe stage then those picked at the immature or partially mature stages. The latter are also much more susceptible to physical injuries and water loss because of their thin cuticle.

Ripeness stage at harvest affects fruit composition and quality. Tomatoes accumulate acids, sugars and ascorbic acid during ripening on the vine [4], [5]. In addition to chemical composition, texture is also very important quality attribute of tomato fruits. Fruit firmness is related to the susceptibility of tomato fruit to physical damage during harvest and storage. Also, it can be the most important consumer preference characteristic which may be tested by fingers [6].

II. MATERIALS AND METHODS

Investigation was carried out at the Lithuanian Research Centre for Agriculture and Forestry in 2007–2008. Tomatoes were grown under integrated tomato growing technology adopted by Institute of Horticulture in no heated greenhouses in the soil. Evaluating fruit ripening impact on the tomato quality, tomatoes were picked at different ripening stages: I – degree of ripeness (100% green tomato fruits), II – degree of ripeness, early stage of ripeness (10-30% colored tomato fruits), III – degree of ripeness – tomato fruits gained color specific to the breed (60-90% colored tomato fruits), IV – degree of ripeness, fully ripen (over 90% colored tomato fruits). The research objective was to evaluate tomato ripening impact on the tomato quality, tomatoes were picked at different ripening stages: I – degree of ripeness (100% green tomato fruits), II – degree of ripeness, early stage of ripeness (10-30% colored tomato fruits), III – degree of ripeness – tomato fruits gained color specific to the breed (60-90% colored tomato fruits), IV – degree of ripeness, fully ripen (over 90% colored tomato fruits).

The research objective was to investigate tomato products and their quality can be well characterized by the content of these elements. Maturity at harvest is very important to composition and quality of tomatoes. This is especially a problem with tomatoes picked green since it is difficult to differentiate between mature and immature-green fruits. Typical and advanced mature-green tomatoes will usually attain a much better flavor at the table-ripe stage then those picked at the immature or partially mature stages. The latter are also much more susceptible to physical injuries and water loss because of their thin cuticle.

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distribution. Plant growing conditions, genotype and fruit ripeness can have a significant impact on carotenoids content in their fruits [10], [11], [12]. According to scientific publications, amount of lycopene in fully ripen tomatoes can vary several times. Heinonen and colleagues found 3.1 mg 100 g⁻¹ lycopene in tomatoes [13]. Tonucci with colleagues reports that average amount of lycopene in tomato is 9.27 mg 100 g⁻¹ [14]. Ngyuen and Schwartz found 3.1-7.7 mg 100 g⁻¹ of lycopene in fresh tomato fruits [1]. According to our data, it was established that the highest amount of accumulated lycopene was found in fully ripen fruits and ranged from 9.21 ('Mižinaı') to 12.69 mg per 100 g⁻¹ ('Vilina') (Fig. 1). The lowest lycopene levels were detected in the green tomato fruits, where lycopene content range from 0.25 ('Mižinaı') to 0.72 mg 100 g⁻¹ ('Veža').

The same trends have been identified with β-carotene (Fig. 2), where the highest amount of β-carotene was found in fully ripen fruits and ranged from 1.40 ('Veža') to 1.69 mg 100 g⁻¹ ('Vilina'). The less amount of β-carotene was detected in the green tomato fruits and ranged from 0.20 ('Mižinaı') to 0.47 mg 100 g⁻¹ ('Veža'). So, according to investigation data, lycopene and β-carotene levels increased consistently in red tomatoes fruit during ripening, only varieties 'Vilina' (between the second and third stages of ripeness) and 'Mižinaı' (between the third and fourth stages of ripeness) were statistically insignificant increases of lycopene and β-carotene content.

Tomato fruit taste is determined by sugar and acid content and their ratio. The more sugar and less acid, the taste is more pleasant [15], [16]. During tomato ripening period, fruit quality is changing. At the beginning of the tomatoes ripening, there are more organic acids and less ascorbic acid in the fruits, and at the end of fruit ripening there are the biggest amounts of dry matter and total sugar in tomatoes. However, about ascorbic acid and total sugar content in tomatoes during ripening we can find a different views, some authors say that tomatoes ascorbic acid levels are increasing rapidly through ripening [17], while others reports, that found no significant differences [18].

Study showed that during fruit ripening ascorbic acid (Fig. 3) and total sugar (Fig. 4) content increased in some tomato varieties, but in others – ascorbic acid and total sugar had declined. The average vitamin C content of fully ripe tomato fruits varies from 10 to 20 mg 100 g⁻¹, although some authors point out that the average ascorbic acid content in tomatoes is 25 mg 100 g⁻¹ [19]. It was established that the highest amount of ascorbic acid (20.4 mg 100 g⁻¹) was in fully ripen fruits of variety 'Vilina'. During fruit ripening ascorbic acid increased rapidly only in variety 'Vilina' fruits. There were no any tendencies detected of ascorbic acid accumulation in other varieties during fruit ripening. Tomato variety 'Mižinaı' accumulated less amount of ascorbic acid in all ripening stages, it varied from 3.8 to 4.2 mg 100 g⁻¹. It is possible to say, that amount of ascorbic acid mainly depends on tomato genotype and less influence had fruit ripening stage. The amount of total sugar varied independently of the fruit maturity. Three of the five investigated varieties accumulated the highest total sugar amount in fully ripe fruits and it had varied from 4.71 to 5.14 %.

![Fig. 1 Lycopene content in different tomato varieties at different ripening stage.](image1)

![Fig. 2 β-carotene content in different tomato varieties at different ripening stage.](image2)
Tomato fruits maturation continues after their harvest, so they may quickly over-ripe, which affects fruit quality and reduce their realization time. Quality of tomato textures determined by tomatoeskin and flesh firmness and their relationship. Tomato fruit firmness is strongly correlated with fruit quality parameters (color, shape, appearance, etc.). Firmness was used as a parameter in determining the quality of tomatoes. Hardness of the fruit can be crucial for the consumer choice. Transportability of fruit is very important for the consumer choice. Hardness of the fruit can be a crucial factor in the consumer choice. Transportability of fruit is very important for the consumer choice. Hardness of the fruit can be a crucial factor in the consumer choice. Transportability of fruit is very important for the consumer choice. Hardness of the fruit can be a crucial factor in the consumer choice. Transportability of fruit is very important for the consumer choice. Hardness of the fruit can be a crucial factor in the consumer choice. Transportability of fruit is very important for the consumer choice. Hardness of the fruit can be a crucial factor in the consumer choice. Transportability of fruit is very important for the consumer choice. Hardness of the fruit can be a crucial factor in the consumer choice. Transportability of fruit is very important for the consumer choice. Hardness of the fruit can be a crucial factor in the consumer choice. Transportability of fruit is very important for the consumer choice. Hardness of the fruit can be a crucial factor in the consumer choice. Transportability of fruit is very important for the consumer choice.

Tomato skin firmness ranged from 109 Ncm\(^{-2}\) in fully ripen fruits of variety 'Milžinai' to 303 Ncm\(^{-2}\) in green fruits of variety 'Aušriai'. Flesh firmness ranged from 6.0 Ncm\(^{-2}\) in fully ripen fruits of variety 'Vilina' to 68.0 Ncm\(^{-2}\) in green fruits of variety 'Milžinai'. Comparison of fully ripen fruits revealed that the strongest skin and flesh of variety 'Aušriai' had the strongest skin and flesh of variety 'Vilina'. The assessment of data showed that tomato skin firmness decreased between III and IV ripening stages in variety 'Skariai' fruits.

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