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# CHEMICAL HETEROGENEITY OF TOMATO INBRED LINES

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*Compositional characteristics of seven lines of tomatoes have been determined. The following parameters were evaluated: dry matter, acidity (citric acid equivalent), Ca-pectate, ash, cellulose, sugars (total, reducing sugars, sucrose), mineral substances (N, P, K, Ca, Na), surface colour and carotenoid content. From a compositional viewpoint, there were no significant differences between lines, but in cellulose, sucrose, mineral substances, carotenoid content, and surface colour parameters, $a^*$, $b^*$, L and h°.*

KEYWORDS: Tomato lines; chemical composition; mineral substances; surface colour; carotenoids

## INTRODUCTION

Tomato fruit is very important for human diet for its carbohydrates content (glucose, fructose, pectic substances, cellulose, hemicellulose), organic acids (citric, malic, succinic, oxalic), vitamin C, macrominerals (P, Mg, Fe, and especially K) content, and low energy value. Red colour of tomato fruit originates mainly from lycopene. Beside the good taste, tomato's beneficial influence on health is also very important. It is good at decreasing the blood pressure, lessening the inflammations of digestive system, gall difficulties, etc. In addition to being a predominant pigment in red tomato fruits, lycopene is well known as good antioxidant.

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## EXPERIMENTAL

Yellow-orange ($O_2$, $O_9$, $O_{10}$, $O_{14}$, $O_{15}$), yellow-green ($O_{13}$), and orange-red (cultivar Novosadski jabucar, NJ) lines of tomato fruit were grown in field conditions.

Pectin content (as Ca-pectate) was determined gravimetrically (1). Total carotenoid content was determined by extraction (petroleum ether : acetone, 97:3) and measured spectrophotometrically at 450 nm (for NJ) and 435 nm (the rest of lines). β-carotene content was determined by coloumn chromatography (1); the coloumn was filled with $Al_2O_3$:$Na_2SO_4$:MgO (3:2:1) and the elution solvent was petroleum ether : acetone (97:3). β-carotene and ζ-carotene were determined on a Beckman DU-60 spectrophotometer.

The other chemical analyses: total acidity, ash, mineral substances, nitrogen, phosphorus, dry matter, cellulose and sugar, were done according to (2 - 4). Surface colour was measured using a tristimuli photocolorimeter MOM color 100.

## RESULTS AND DISCUSSION

Chemical composition of tomato fruit investigated in this study is presented in Table 1. As reported in the literature (5-8), chemical composition of tomato fruit vary depending on the variety and breeding conditions.

**Table 1.** Chemical composition of tomato fruits

| Line | DM (%) | Total acidity* | Ca-pectate* | Ash* | Cellulose* | Total sugars* | Reducing sugars* | Sucrose* |
|---|---|---|---|---|---|---|---|---|
| $O_2$ | 5.1 | 7.95 | 0.726 | 9.31 | 13.18 | 42.28 | 41.62 | 0.630 |
| $O_9$ | 6.5 | 5.89 | 0.829 | 7.62 | 8.06 | 39.40 | 38.00 | 1.335 |
| $O_{10}$ | 5.8 | 6.92 | 2.061 | 9.90 | 7.33 | 44.45 | 42.31 | 2.043 |
| $O_{13}$ | 5.7 | 6.98 | 1.057 | 7.92 | 9.82 | 42.04 | 38.99 | 2.903 |
| $O_{14}$ | 5.4 | 6.85 | 2.422 | 8.58 | 6.26 | 44.48 | 43.67 | 0.767 |
| $O_{15}$ | 6.0 | 6.34 | 2.797 | 8.44 | 9.07 | 43.10 | 40.88 | 2.108 |
| NJ | 5.6 | 6.13 | 4.253 | 9.35 | 3.85 | 40.81 | 39.96 | 0.806 |
| Mean | 5.7 | 6.72 | 2.021 | 8.73 | 8.22 | 42.37 | 40.78 | 1.513 |
| CV% | 6.57 | 2.31 | 31.11 | 10.65 | 24.46 | 0.45 | 0.66 | 26.36 |

DM – Dry matter; * - per cent / dry matter

Dry matter of tomato fruit is comprised of water-soluble dry matter (about 88%), originating mainly from sugars, acids, proteins and water-soluble pectic substances (pectinic acid). Cellulose, hemicellulose, pectic acid and protopectin are water-insoluble components.

Organic acid content also vary depending on the variety and the maturity stage, and influences the suitability for processing of tomato fruit. Citric acid is the predominant organic acid in tomato fruit. Total acidity (as citric acid equivalent) in samples was 6.13-

7.95% per dry matter, which is in accordance to the literature (6, 9). Sugar/acidity ratio is very important in defining maturity stage. Pectic substances of tomato fruit can be in the water-insoluble (protopectin and pectic acid) and water-soluble (pectinic acid) forms. These compounds increase fruit flash elasticity and mechanical strengh, join the cells and physically bind the water, which is of great importance to the rheological properties of fruit. Ca-pectate content in tomato fruits $O_{10}$, $O_{14}$ and $O_{15}$ was a little bit higher than the aveage value (2.02%), while in NJ it differed considerably (4.25%).

The cellulose content, as well as hemicellulose and lignin, is very important in lowering the risk of developing type II diabetes, heart desease, etc. It may also help preventing high cholesterol and fighting obesity. High-fiber foods help move waste through the digestive tract easier and faster, reducing strain, and limiting contact between potentially harmful substances and the gastrointestinal tract (10). The average cellulose content in tomato fruit varied noticeably, indicating that NJ variety contained 3.85% cellulose per DM, which is far less than 13.18% of cellulose per DM in the variety $O_2$. This points out that the dietary fibre content depends on the variety and breeding conditions.

Sugars take part of about 45-60% in dry matter, mainly as fructose and glucose, while sucrose content vary depending on the variety and the time of harvest. Tomato fruit samples investigated contained 39.40-44.48% of sugars.

By ashing of the samples, water, organic and other substances segregate, while mineral matter remain as dry residues - ash. The ash content in tomato fruit samples was 7.62-9.90% per DM. Ash content could be one of criteria for estimation of biological value, quality and hygienic safety.

Mineral substances are present as salts of organic or inorganic acids or as complex organic combinations. They are in many cases dissolved in cellular juice. Vegetables are richer in mineral substances as compared to fruits. Among the vegetables which are especially rich in mineral substances are spinach, carrot, cabbage and tomato (11). Important quantities of potassium and absence of sodium chloride give a dietetic value to fruit and vegetables and their processed products. The obtained data for mineral composition (N, P, K, Ca, Na) (Table 2) showed that there were significant differences between six lines of tomato fruit investigated. Line $O_2$ had the highest content of all elements (8959 mg/kg); line $O_{14}$ was also distinguished for the high mineral substance content (8166 mg/kg); line $O_9$ had the lowest content (6779 mg/kg). Among all investigated elements, potassium was the predominant (4148 mg/kg), which is in agreement with the findings of other authors (12, 13).

**Table 2.** Mineral substance content of tomato fruits (mg/kg)

| Line | N | P | K | Ca | Na | Σ |
|---|---|---|---|---|---|---|
| $O_2$ | 2787 | 393 | 4751 | 861 | 167 | 8959 |
| $O_9$ | 2083 | 339 | 3600 | 624 | 133 | 6779 |
| $O_{10}$ | 2577 | 340 | 3906 | 709 | 133 | 7665 |
| $O_{13}$ | 2443 | 344 | 4109 | 654 | 144 | 7684 |
| $O_{14}$ | 2223 | 458 | 4522 | 788 | 175 | 8166 |
| $O_{15}$ | 2373 | 430 | 4119 | 722 | 150 | 7794 |

**Table 2.** Continued

| | | | | | | |
|---|---|---|---|---|---|---|
| NJ | 2740 | 348 | 4032 | 791 | 146 | 8057 |
| Mean | 2461 | 379 | 4148 | 736 | 150 | |
| CV% | 6.06 | 4.45 | 2.85 | 11.17 | 8.20 | |

Colour of tomato fruit may be: orange, yellow, red, purple, even white. Red colour of the fruit originates from lycopene, while in yellow fruits lycopene is present in traces. Apart from lycopene, other carotenoids can be found, but in smaller amounts. Visually, NJ was redish, while other lines were yellowish. The highest a* (Table 3) was measured in line NJ (19.85), while other lines had markedly lower a* values (<5). Moreover, NJ had the lowest b* (18.35) among the samples of tomato fruit. It was expected that NJ should be the darkest sample, according to L value. As hue angle (h°) showed, line NJ was of orange-red colour in CIELab colour wheel (h°=42.75); $O_2$, $O_9$, $O_{10}$, $O_{14}$, and $O_{15}$ were yellowish-orange; $O_{13}$ was yellowish-green.

**Table 3.** Surface colour of tomato fruits

| | **NJ** | **$O_2$** | **$O_9$** | **$O_{10}$** | **$O_{13}$** | **$O_{14}$** | **$O_{15}$** |
|---|---|---|---|---|---|---|---|
| $a^*$ | 19.85 | 2.23 | 4.38 | 2.97 | -3.97 | 2.43 | 1.5 |
| $b^*$ | 18.35 | 29.72 | 28.63 | 33.04 | 29.57 | 32.41 | 28.29 |
| L | 29.1 | 42.03 | 40.5 | 41.65 | 44.17 | 41.29 | 42.1 |
| c | 27.03 | 29.8 | 28.96 | 33.17 | 29.83 | 32.5 | 28.33 |
| h° | 42.75 | 85.71 | 81.3 | 84.86 | 97.65 | 85.71 | 86.96 |

The highest content of carotenoids was in line $O_2$ (315 mg/kgDM); the lowest in line $O_{13}$ (5 mg/kgDM). Red carotenoid, lycopene, together with β-carotene, was predominant in red-coloured tomato fruits of line Novosadski jabucar, while ζ-carotene was predominant in yellowish tomato fruits in other lines investigated (Table 4).

**Table 4.** Carotenoid content in tomato fruits (mg/kgDM)

| **Line** | **Total carotenoid content** | **β-carotene** | **ζ-carotene** |
|---|---|---|---|
| $O_2$ | 315 | — | 126 |
| $O_9$ | 232 | — | 158 |
| $O_{10}$ | 290 | — | 69 |
| $O_{13}$ | 5 | — | 3 |
| $O_{14}$ | 109 | — | 77 |
| $O_{15}$ | 237 | — | 82 |
| NJ | 273 | 15 | — |
| Mean | 208 | — | 86 |

## CONCLUSION

Tomato fruit lines investigated in this work did not show great differences in the main chemical composition, except for cellulose ($O_2$ and NJ) and sucrose ($O_{10}$, $O_{13}$ and $O_{15}$) content. High amount of mineral substances was found in line $O_{14}$, with potassium as predominant in all samples, as expected. Line Novosadski jabucar had orange-red colour, $O_{13}$ was yellowish-green, while other samples were yellowish-orange. Total carotenoid content was highest in line $O_2$, and lowest in $O_{13}$. Fruits with yellowish colour contained ζ-carotene, while red fruits of NJ line contained β-carotene.

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## ХЕМИЈСКА ХЕТЕРОГЕНОСТ ЛИНИЈА ПАРАДАЈЗА

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У овом раду разматране су разлике црвене, жуте и жуто-зелене линије парадајза у погледу хемијског састава (сува материја, киселост, Са-пектат, пепео, целулоза, шећери), минералног састава (азот, фосфор, калијум, калцијум, натријум), профила каротеноида и параметара површинске боје ($a^*$, $b^*$, L, h°). Битне разлике уочене су у садржају целулозе, сахарозе и минералних материја. β-каротен је био заступљен у црвеној линији Новосадски јабучар, док је ζ-каротен био заступљен код осталих узорака.

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