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The Effect of the Production Methods and Growing Cycles on the Content of Some Mineral Matters in Tomato Fruit

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Abstract: Tomato investigations were carried out under the greenhouse and field conditions. The aim was to determine the extent to which the greenhouse conditions influence the chemical composition of tomato fruits. The plants grown under the field conditions were used as the control. Tomato experiments were carried out over different periods of time - during the winter and spring (January-June), under the greenhouse conditions and during the spring and summer (May-September), under the field conditions. The contents of zinc, manganese and copper were determined in ripe tomato fruits.

Key words: tomato, greenhouses, production, fruit, mineral matters.

Introduction

Tomato is widely used as food by many nations, particularly at southern latitudes. It is especially valued for high content of carotine (vitamin A) and mineral salts. It can be used fresh and for the production of different products.

As far as mineral matters are concerned, tomato has high amounts of potassium and phosphorus, a significant amount of calcium, magnesium and iron and it also contains sodium, copper, zinc, manganese and many other minerals.

The content of some minerals in tomato fruits depends on different factors, such as the climatic ones, physical and chemical properties of the soil,

fertilization etc. As we can see from the published data (Sarro et al., 1987; Zuang, 1986; Turski and Chmielewska, 1986), the chemical composition of tomato also depends on the tomato growing conditions - whether tomato fruits are produced under field or under greenhouse conditions. This was the reason for the investigation of the effects of the greenhouse growing on the content of zinc, manganese and copper in tomato.

Material and method

The experiments were carried out in 1995 and 1996 under the greenhouse and the field conditions (the control). The greenhouse investigated tomato was grown over the period January-June, whereas the field investigated tomato was grown over the period May-September. Dutch hybrid Carmello was used, being suitable for the greenhouse and field growing. The samples for the tomato fruit chemical analyses were collected twice during the tomato harvest. Ripe and whole fruits were used. After being homogenized, they were destroyed by the dry-moist operation, burned at 420^{0}C and then treated with nitrogen acid until they were completely digested. The content of zinc, manganese and copper was determined by Atomic Absorption Spectrophotometry. The results presented represent mean values for three replications and two harvests.

The experiments were carried out on eutric cambisol. 1 kg of that soil contained c. 80 mg of zinc, c. 510 mg of manganese and c. 18 mg of copper. This soil type is very suitable for tomato growing.

Climatic conditions in 1995 and 1996 were almost identical. There were some differences, though, which did not significantly influence our experiments. The greenhouse tomato growing was carried out under controlled conditions (heating, irrigation, etc.).

Results and Discussion

A rather strong influence of the greenhouse growing conditions was observed in the case of the content of zinc in tomato. 1 kg of the greenhouse produced tomato fruits contained 1.542 mg of zinc. This was by 0.314 mg more as compared with the field produced tomato fruits containing 1.228 mg of zinc. It may be concluded that the greenhouse growing conditions may increase the content of zinc in tomato fruits. (Tab. 1).

Tab. 1 Zinc content in tomato fruits

Trial variant		Zinc content (mg/kg fresh fruits) Trial years 1995	1996	Average
Greenhouse conditions		1.680	1.405	1.542
Field conditions		1.339	1.118	1.228
Average		1.509	1.261	1.385
LSD	0.05	0.275	0.202	
	0.01	0.618	0.466	

The content of manganese was higher in the field produced tomato fruits. 1 kg of these fruits contained 0.547 mg of manganese, which was by 0.134 mg more as compared to the value recorded in the greenhouse produced tomato fruits. It was also observed that the content of manganese was also influencd by the tomato growing conditions. (Tab. 2).

Tab.2 Manganese content in tomato fruits

Trial variant		Manganese content (mg/kg fresh fruits) Trial years 1995	1996	Average
Greenhouse conditions		0.399	0.427	0.413
Field conditions		0.531	0.563	0.547
Average		0.465	0.495	0.480
	0.05	0.111	0.108	
LSD	0.01	0.258	0.249	

No influence of the tomato growing conditions was observed in the case of the copper content, amounting to 0.499 mg (greenhouse growing) and 0.488 mg (field production). The difference was only 0.011 mg.

Tab.3 Coper content in tomato fruits

Trial variant		Coper content (mg/kg fresh fruits) Trial years 1995	1996	Average
Greenhouse conditions		0.492	0.506	0.499
Field conditions		0.532	0.445	0.488
Average		0.512	0.475	0.493
	0.05	0.146	0.186	
LSD	0.01	0.337	0.394	

The greenhouse growing conditions exerted a rather strong influene on the chemical composition of tomato, considerably increasing the content of zinc in tomato fruits. This was also observed by other research workers (Leoni et al., 1987, Kosobrukhov et al., 1988), in whose opinion the microclimatic conditions inside the greenhouse have a favourable efffect on the migration of zinc from the tomato stem and leaves to its fruits. Some authors (Kabata-Pendias and Pendias, 1986) are of the opinion that the zinc content in tomato fruits mostly depends on the soil fertility, that is, more precisely, phosphorus and calcium induce the absorption of zink by plants. It has been proved that zinc is contained by many different enzymes, that it influences the metabolism of carbohydrates etc. It also increased the resistance of plants to dry and warm weather as well as to bacterial and fungal diseases.

The content of manganese in tomato fruits was reduced under the greenhouse conditions, which was not in accordance with the results obtained by Zuang (1985), according to which the mentioned mineral did not react to the greenhouse tomato growing conditions. According to Turski and Chmielewska (1986), however, tomato reduces the content of manganese to a great extent if it is produced under the greenhouse conditions. Manganese moves slowly through the plant and mostly stays in the root and young leaves, which results in its low and unstable content in the fruits and seed.

A very high stability of copper was determined, which was also observed by a number of authors (Kabata-Pendias, 1986., Rhoads et al., 1989), who maintain that copper is highly resistant to various influences (temperature, moisture, time of sowing, etc.). Copper mostly stays in the root and leaves. Fruits of some plant species also have a high content of copper. They are rich in proteins (oats, wheat etc.), which is not the case with tomato.

Conclusion

Based on the investigation of the effects of the production methods as well as of different growing cycles on the content of mineral matters in tomato fruit, the following conclusions may be drawn:

- With regard to the methods of production, the greenhouse growing had a significant effect on the content of mineral matters in tomato fruit.
- The intensity and the nature of the effects of the greenhouse tomato production as compared to the field production were different for each mineral matter and its content in tomato fruit.
- The content of zinc was higher in the greenhouse produced tomato fruits than in the field produced ones, as compared to the inverse result of the content of manganese, which was higher in the fruits produced under field conditions. The content of copper did not easily change in plant organs, based on which it was determined that the copper content was not influenced by the tomato production methods.

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EFEKAT NAČINA PROIZVODNJE I CIKLUSA GAJENJA NA SADRŽAJ NEKIH MINERALNIH MATERIJA U PLODU PARADAJZA

-originalni naučni rad-

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Rezime

Tokom dve vegetacione sezone proučavano je gajenje paradajza u uslovima otvorenog polja i zaštićenog prostora, odnosno staklenika. Ispitivanja su obavljena da bi se utvrdio eventualni uticaj različitih načina proizvodnje i ciklusa gajenja na sadržaj nekih mineralnih materija u plodu paradajza.

Paradajz je gajen preko rasada. U ogledima je korišćen holandski hibrid Carmello, indeterminantnog tipa, kasnije grupe zrenja, pogodan za uzgoj u zaštićenom prostoru i na otvorenom polju. U fazi tehnološke zrelosti plodova određivan je sadržaj cinka, mangana i bakra primenom najsavremenijih laboratorijskih metoda.

Dobijeni rezultati istraživanja pokazuju da je način proizvodnje paradajza u zaštićenom prostoru (staklenici) ispoljio značajne razlike na sadržaj ispitivanih mineralnih materija u plodu, u odnosu na gajenje na otvorenom polju. Sadržaj cinka je povećan, a sadržaj mangana smanjen u plodovima paradajza proizvedenog u staklenicima. Sadržaj bakra bio je veoma ujednačen, jer je za njega karakteristično da teško menja svoj sadržaj u biljnim organima, tako da njegov sadržaj u plodu nije zavisio od načina proizvodnje paradajza.