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EFFECT OF GREENHOUSE CONDITIONS ON Zn, Fe AND Cu CONTENT IN TOMATO FRUITS

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Abstract: Tomato investigations were carried out under greenhouse and field conditions. The aim was to determine the extent to which greenhouse conditions influence the chemical composition of tomato fruits. Plants grown under field conditions were used as the control. Tomato trials were performed during different periods. Greenhouse trials were carried out in the winter and the spring period (January-June), and field trials in the spring and the summer period (May-September). Zinc (Zn), iron (Fe) and copper (Cu) content was established in ripe tomato fruits. Greenhouse conditions were found to effect zinc and iron content in tomato, whereas copper content was unaltered.

Key words: greenhouse, open field, zinc, iron, copper.

Introduction

Tomato is a wide-spread foodstuff in the diet of people in many countries, and particularly in those situated on southern geographic latitudes. It is extremely highly valued due to the high content of carotene (vitamin A) and mineral salts. It is used both as a fresh vegetable and for processing.

Of mineral matter, tomato plants contain the largest quantities of potassium, although the quantities of calcium, magnesium and iron are also significant. Tomato also contains sodium, copper, zinc, manganese and numerous other minerals.

The amounts of individual minerals present in tomato fruits depend on various factors, such as climatic factors, physical and chemical soil properties, fertilization and other. Data available from the literature (Sarro et al., 1987; Turski and Chmielewska, 1986; Walace, 1986) point out to the fact that the chemical composition of tomato fruits may also depend on whether they have

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been produced under field or greenhouse conditions. This motivated us to investigate in our trials the influence of greenhouse conditions on the content of zinc, iron and copper in tomato fruits.

Material and Methods

Greenhouse and field trials (control) were performed in 1998 and 1999. Tomato plants investigated in greenhouse were grown in the January-June period, whereas field trials were carried out in the May-September period. The Dutch hybrid Carmello suitable for both greenhouse and field production was used. Samples for chemical fruit analyses were taken two times in the course of the tomato harvest period. Only ripe and completely healthy fruits were used. Following homogenization, these fruits were disintegrated using the dry-wet treatment, then burnt at 420^0C, and finally treated with nitric acid to reach complete disintegration. Zinc, iron and copper contents were established with the use of atomic absorption spectrophotometry (Varian AA_5). The results presented in this paper are mean values for three replications and two harvest periods.

The trials were performed on eutric cambisol. The quality of the greenhouse soil was more favourable (with regard to humus, P, K and microelements content). One kilogramme of this type of soil contains approx. 80 mg of zinc, approx. 19.430 mg of iron and approx. 18 mg of copper. As such, it is highly suitable for tomato growing. Its acidity (pH) amounted to 6.4 (under field conditions) and 6.7 under greenhouse conditions. Eutric cambisol soil type ranks high with regard to quality and is known to favour vegetable production.

Climatic conditions in 1998 and 1999 were approximately the same, but there were also some differences, which, however, had no significant effect on the said trials. The conditions in the greenhouse were controlled (heating, irrigation, etc.).

Results and Discussion

Greenhouse conditions displayed a rather strong influence on zinc content in tomato fruits. One kilogramme of greenhouse produced tomato fruits contained 1.542 mg of zinc. This was by 0.314 mg more as compared with field produced tomato fruits featuring a zinc content of 1.228 mg. Consequently, it may be concluded that greenhouse conditions may influence an increase of the content of this element in tomato fruits.

Numerous authors reported a substantially raised Zn content in greenhouse tomato fruits (Leoni et al., 1987; Miliev and Alexiev, 1996). This may be attributed to the conditions in greenhouses which favour the transfer (migration) of the zinc from the stalk and leaves into tomato fruits. Some authors (Kabata-Pendias and Pendias, 1986) are of the opinion that zinc content in tomato fruits primarily depends on soil fertility. In fact, this role is ascribed to phosphorus and potassium which stimulate zinc absorption by the plants. It has been proved that zinc is present in the composition of several enzymes, that it influences the metabolism of carbohydrates, etc. It is also believed to increase plant resistance to dry and hot weather, as well as their resistance to bacterial and fungal diseases.

T a b. 1. - Effect of greenhouse conditions on zinc content in tomato

Trial variant	Zinc content (mg/kg fresh fruits)		
	1998	1999	Average
Greenhouse	1.680	1.405	1.542
Open field	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 results obtained for iron are inverse. In fact, iron content was higher in field produced tomato fruits. One kilogramme of these fruits contained 2.832 mg of iron, which was by 0.596 mg more as compared to the value recorded for greenhouse produced tomato fruits. This evidences that iron content is susceptible to tomato growing conditions.

T a b. 2. - Effect of greenhouse conditions on iron content in tomato

Trial variant	Iron content (mg/kg fresh fruits)		
	1998	1999	Average
Greenhouse	2.028	2.444	2.236
Open field	2.618	3.046	2.832
Average	2.323	2.745	2.534
LSD 0.05	0.387	0.419	-
0.01	0.894	0.972	-

These results are not in accordance with the data obtained by J a n k u l o s k i et al. (2002) because according to them iron content was unaltered in greenhouse tomato. However, according a K o s o b r u k h o v et al. (1988) important reductions of iron quantities in tomato fruits are evident in case of greenhouse production. Slow migration through the plant (the phloem) is characteristic for iron, so that it mostly remains in the root and in young leaves. This results in low and unstable content of this element in the fruits and in the seed.

The values of copper content were constant amounting to (0.499 and 0.488mg). The difference obtained was only 0.011mg.

Thus, it can be concluded that the copper content in tomato was substantially stable. This is also confirmed by several researchers (Kabata-Pendias and Pendias, 1986; Rhoads et al., 1989), who believe copper to be very resistant to various influences (temperature, moisture, time of harvest, etc.). It mostly remains in the root and in the leaves. In some plant species also the fruits contain rather large amounts of copper. Those are the species with fruits rich in proteins (barley, wheat, etc.), which is not the case with tomato.

T a b. 3. - Effect of greenhouse conditions on copper content in tomato

Trial variant	Copper content (mg/kg fresh fruits)		
	1998	1999	Average
Greenhouse	0.492	0.506	0.499
Open field	0.532	0.445	0.488
Average	0.512	0.475	0.493
LSD 0.05	0.146	0.186	-
0.01	0.337	0.394	-

Conclusion

Greenhouse conditions may have a significant effect on the content of mineral matter (Zn, Fe and Cu) in tomato fruits. The intensity and the nature of this influence is not the same for all minerals. A characteristic of some minerals (copper) is that their content in individual plant organs hardly changes. All this is extremely closely connected with the role of these minerals in nature.

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UTICAJ STAKLENIČKIH USLOVA NA SADRŽAJ Zn, Fe I Cu U PLODOVIMA PARADAJZA

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Rezime

Paradajz je proučavan u stakleniku i na otvorenom polju. Proučavanja su obavljena da bi se odredio uticaj staklenika na hemijski sastav plodova paradajza. Otvoreno polje je uzeto kao kontrola. Ogledi sa paradajzom su izvodjeni u različito vreme. U stakleniku su izvodjeni u toku zime i proleća (januar-juni), a na otvorenom polju su izvodjeni u toku proleća i leta (maj-septembar). U zrelim plodovima paradajza odredjen je sadržaj cinka (Zn), gvoždja (Fe) i bakra (Cu). Staklenik je uticao na sadržaj cinka i gvoždja u paradajzu, dok se sadržaj bakra nije menjao.

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