THE INFLUENCE OF SALT STRESS ON ASCORBIC ACID (VITAMIN C) IN THE FRUITS OF SOME TOMATO CULTIVARS FROM N-E ROMANIA

INFLUENŢA STRESULUI SALIN ASUPRA CONŢINUTULUI DE ACID ASCORBIC (VITAMINA C) DIN FRUCTELE UNOR GENOTIPURI DE TOMATE DIN NORD-ESTUL ROMÂNIEI

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Abstract: *Vitamin C or ascorbic acid is an organic acid with antioxidant properties, involved in a number of processes taking place in living cells. Through their efforts to adapt to the saline stress, plants have to increase the antioxidant level by increasing, mainly, the ascorbic acid. The research was conducted under greenhouse condition. The biological material was represented by seven local tomatoes populations collected from areas with saline soils from Moldavia region and compared with commercial type salt-tolerant tomato. Tomato genotypes in the study were subjected to salt stress for a period of 30 days is constantly wetted with saline solution to a concentration of 100 mM and 200 mM. The content of vitamin C in fruit was determined by using the titrimetric method. The research on the vitamin C content from tomatoes fruit showed that, as the concentration saline increases, the concentration of ascorbic acid raises too.*
Key words*:* salinity, stress, tomatoes, vitamin C, adaptation

Rezumat: *Vitamina C sau acidul ascorbic, este un acid organic cu proprietăţi antioxidante, implicat într-o serie de procese care se desfăşoară în celulele vii. Plantele, prin eforturile de adaptare la stresul salin, sunt nevoite sa-şi mărească nivelul de antioxidanţi în principal prin creşterea conţinutului de acid ascorbic Au fost luate în studiu şapte genotipuri de tomate colectate din solurile saline ale regiunii Moldovei şi un soi comercial rezistent la salinitate. Acestea au fost expuse stresului salin pe o perioadă de 30 de zile, fiind udate constant cu soluţii saline de concentraţie 100 mM şi 200 mM. S-a determinat conţinutul de vitamina C din fructe după metoda titrimetrică pentru determinarea acidului L – ascorbic. Cercetările au demonstrat că odată cu creşterea concentraţiei saline creşte şi valoarea concentraţiei acidului ascorbic.*
Cuvinte cheie: salinitate, stres, tomate, vitamina C, adaptare

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INTRODUCTION

Exposure of plants to abiotic stresses such as high salinity, drought, extreme light and temperature leads to major loss in crop productivity worldwide. Among the various abiotic stress factors, salinity is the biggest threat to plant agriculture. Salt stress affects almost every aspect of the physiology and biochemistry of plants and significantly reduces yield. Therefore, a concerted effort to understand the effects of salinity on plants is essential to combat the world's salinity problem (Murshed *et al*., 2014).

According to the FAO guideline tomato is moderately tolerant to salinity (Munns and Tester, 2008). It has been shown that irrigation with saline water may improve the taste of both round and cherry tomatoes by increasing their sugar and organic acid content. A controlled level of stress, imposed via irrigation with saline water, is also used to improve quality and flavour of processed tomatoes. Tomato fruits are a valuable source of several nutrients such as vitamin C (Pascale *et al*., 2001).

Vitamin C serves as a cofactor in the synthesis of collagen needed to support cardiovascular function, maintenance of cartilage, bones, and teeth, as well as being required in wound healing. The National Academy of Sciences has recommended 90 mg/day of the vitamin for adult males and 75 mg/day for adult females. Although vitamin C can be obtained from the consumption of fresh meat, it is destroyed by heating and is more typically obtained from plant sources. Ascorbic acid is present in high amounts generally in fruits and leafy vegetables whereas grains typically have much lower levels of the vitamin, particularly in dried grain. Moreover, the diet of a significant portion of the global population consists largely of plant-based foods (Gallie, 2013).

Although post-harvest reductions in ascorbic acid can occur, particularly in leafy vegetables, increasing vitamin C content would help to preserve the nutritional quality of stored foods. As a result, much research has focused on developing strategies to increase vitamin C content in plant foods to improve their nutritional value including strategies to increase the biosynthetic capacity of plants and to increase the recycling of ascorbic acid once it has been used in a reaction (Hancock and Viola, 2005).

MATERIAL AND METHOD

The research was conducted under greenhouse condition from USAMV Iaşi in the year 2016.

The biological material was represented by six local tomatoes populations collected from areas with saline soils from Moldavia region and compared with commercial type salt-tolerant tomato (*Ursula* $_{F1}$) from Israel.

The bifactorial experience was conducted in a pots experiment in randomized blocks with three repetitions. Six tomato genotypes (*Moşna*$_2$, *Şcheia*, *Copalău*$_3$, *Copalău*$_4$,

Copălău$_5$, Moşna$_3$) studied were subjected to salt stress for a period of 30 days is constantly wetted with saline solution to a concentration of 100 mM and 200 mM.

The extraction of ascorbic acid from the sample, using oxalic acid solution, or solution of metaphosphoric acid and acetic acid and the titration with 2.6 dichlorophenolindophenol, until obtaining a light pink color.

For interpretation of the results was used Anova Two Factor.

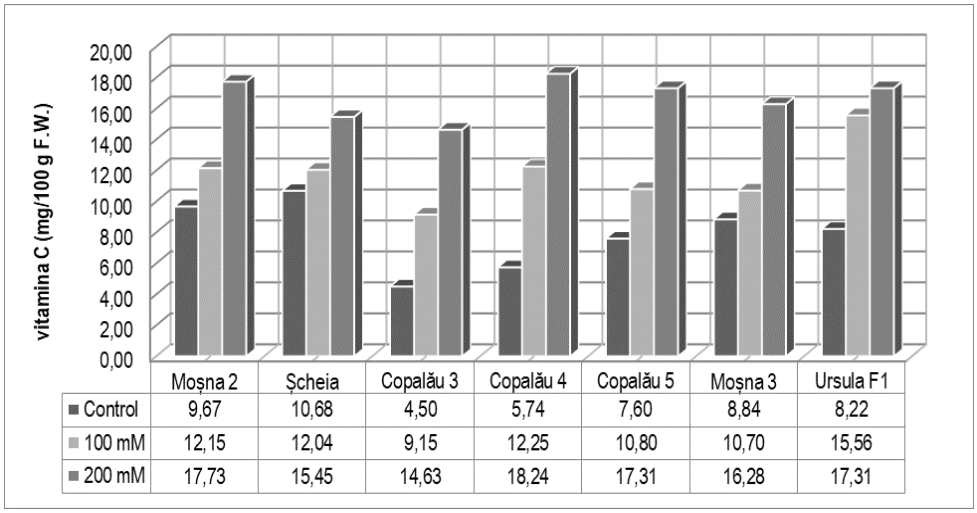
RESULTS AND DISCUSSIONS

Vitamin C or ascorbic acid is an organic acid with antioxidant properties, involved in a number of processes taking place in living cells.

Through their efforts to adapt to the saline stress, plants have to increase the antioxidant level (Ehret *et al.,* 2013) by increasing, mainly, the ascorbic acid, this fact being also showed by our determinations.

The researches conducted in this study on the vitamin C content from tomatoes fruit showed that, as the concentration saline increases, the concentration of ascorbic acid raises too. For the control variant, the maximum value was registered in the genotype *Şcheia* - 10.68 mg and the minimum value in the genotype *Copălău$_3$* - 4.50 mg. For the variant treated with saline solution of 100 mM compared to control variant, all genotypes had higher values, the maximum of 15.56 mg being determined in *Ursula $_{F1}$* variety's fruit and the minimum value of 9.15 mg was registered in the genotype *Copălău$_3$* (fig. 1).

For the variant subjected to a 200 mM saline stress concentration compared to the control variant, all genotypes had higher values, the minimum value being for the genotype *Copălău$_3$* - 14.63 mg, and the maximum for genotype *Copălău$_4$* - 18.24 mg.



	Moşna 2	Şcheia	Copalău 3	Copalău 4	Copalău 5	Moşna 3	Ursula F1
Control	9,67	10,68	4,50	5,74	7,60	8,84	8,22
100 mM	12,15	12,04	9,15	12,25	10,80	10,70	15,56
200 mM	17,73	15,45	14,63	18,24	17,31	16,28	17,31

Fig. 1 Vitamin C concentration (mg / 100 mg F.W.) from tomato fruit subjected to saline stress over a period of 30 days

Compared to control cultivar *Ursula$_{F1}$* used (8.22 mg), three of the genotypes *Moşna$_2$, Şcheia, Moşna$_3$* have higher values, between 8.84 - 10.68 mg vitamin C / 100 g F.W. For the variant with a saline stress of 100 mM, all studied genotypes present salinity values between 9.15 - 12.25 mg, lower than those of the resistant cultivar (15.56 mg). Compared to *Ursula$_{F1}$* (17.31 mg.), the variant subjected to a saline solution of 200 mM, 2 genotypes *Moşna$_2$* and *Copălău$_4$* have higher values, between 17.73 -18.24 mg.

The results on the content of vitamin C in the fruit of some tomatoes genotypes subjected to saline stress of 100 mM showed that this level of salinity has favored the synthesis of ascorbic acid in concentrations of 1.36 - 7.34 times higher compared to the control variant. For the variant treated with a saline solution of 200 mM, the values for the concentration of vitamin C have been 4.77 - 12.50 times higher than for the control variant. However, other studies (Dumas *et al.*, 2003) showed a decrease in the content of ascorbic acid in conjunction with the saline stress. The reason may be either the degree of salinity used, which induces different stress levels, or the genetic differences between the biotypes of cultivated tomatoes, which influences the resistance to saline stress, or other factors, such as the degree of maturation.

After conducting the variance analysis on genotypes of tomatoes subjected to stress saline for 30 days, it was found that the accumulation of ascorbic acid was insignificantly influenced by *a factor – genotype*, there being no significant differences among the genotypes of the same variant, but *b factor - NaCl concentration* has a very significant influence on the concentration of vitamin C (tab. 1).

Table 1.

The variance analysis of the tomato genotypes under stress salinity of stomatal conductance

after 30 days

Source of variance	SP	GL	MS	F	P-value	F crit	Influence
Genotype	33.942	6	5.657052	2.409588	0.09183	2.996	NS
Concentration	273.054	2	136.5271	58.15292	0.000001	3.885	***
Error	28.1727	12	2.347726				
Total	335.169	20					

Anova Two- Factor: ^{NS} insignificant statistical differences (p≥0,05); * significant statistical differences (p ≤ 0.05); ** distinctly significant statistical differences (p≤0,01); *** highly significant statistical differences (p≤0.001), F> F crit null hypothesis rejected

After running *Test T,* it has been found that there are distinctly significant statistical differences between the control variant and the variant subjected to saline stress of concentration of 100 mM. There are highly significant statistical differences between the control variant and the variant subjected to saline stress of concentration of 200 mM, as well as between the variants treated with saline solution (tab.2).

Table 2.

Statistical differences of the content of vitamin C in fruit (mg / 100 mg F.W.) observed between the control variant and the variants treated with saline concentration

Compared variants	t-stat	P two-tail	Meaning
I-II	-4.4616	0.004275	**
I-III	-9.6544	0.000071	***
II-III	-7.6605	0.000258	***

t-Test Paired Two Sample for Means : ^{NS} insignificant statistical differences ($p \geq 0,05$) between variants; *significant statistical differences ($p \leq 0.05$) between variables; ** distinctly significant statistical differences ($p \leq 0,01$) between variants; *** highly significant statistical differences ($p \leq 0.001$) between variants, I-control, II- 100 Mm, III- 200 mM

CONCLUSIONS

The results on the content of vitamin C in the fruit of some tomatoes genotypes subjected to saline stress of 100 mM showed that this level of salinity has favored the synthesis of ascorbic acid in concentrations of 1.36 - 7.34 times higher compared to the control variant. For the variant treated with a saline solution of 200 mM, the values for the concentration of vitamin C have been 4.77 - 12.50 times higher than for the control variant.

Salinity increased the contents of acid ascorbic on the tomato fruits and thus improved the fruit quality.

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