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POSSIBLE ROLE OF SOME PLANT CONDITIONING MATERIALS ON THE PRODUCTION OF TOMATO AS A FUNCTIONAL FOOD

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ABSTRACT

Tomatoes and tomato products are among the most appropriated functional foods. In our study, we used natural soil and plant conditioning materials in the production of tomato in an open field trial, in the study garden of Kecskemét College. A plant conditioning product made by phosphoric acid digestion of zeolite tufa (Rioplant), combined with Plantafosz Universal and Zeon A was used. Our test plant was tomato cultivar 'Mobil'. Different doses and combinations of conditioning materials were used. Tests were made in our laboratory (Soil and Plant Testing Laboratory of Faculty of Horticulture). Total crop quantity, crop size and total pieces of the fruits were tracked in the vegetation phase and compared to the control plants. Our results showed that soil and plant conditioning materials had no significant effect on the crop quantity. Regarding the crop quality however, vitamin C content increased in fruits after each treatment, compared to the control. This increase was significant after combined treatment with Rioplant and Plantafosz Universal.

Keywords: tomato, functional food, soil conditioner, crop quantity, vitamin C.

INTRODUCTION

There is an increasing demand for environmentally friendly plant growing technologies and growing of healthier vegetables and fruits. These horticultural products are generally accepted to be beneficial foods thanks to their high mineral, vitamin and so called "bioactive" substance contents, positive effects on the acid-alkaline balance of the body, health and prevention of disease. Conventional vegetables and fruits are often categorized as functional foods.

The term 'functional food' is commonly used but it does not have a universal definition. However, specific definitions have been put forward by many organizations. The concept originally conceived in Japan; first was used by the Japanese Ministry of Health, in 1991, and by FAO in 2007 and different dietetic associations thereafter. Functional foods contain "bioactive compounds" or naturally occurring chemicals that act on our bodies and offer the health and wellness benefits that have been linked to functional foods (ASHWELL, 2001, VAN KLEEF ET AL., 2005, BABOOTA ET AL., 2013). These foods offer the potential of reducing the risk of chronic diseases. Functional foods can be divided into categories, according to their health benefit: heart, bone, intestine or immune system. In this way, there is a lot of potential for functional foods to contribute to improved health, particularly for older adults.

As we have mentioned that "functional food" has no universally accepted definition, some categorizations define functional foods as conventional foods that have been modified; this elimination of the conventional fruits and vegetables from functional foods is ineligible. A functional food can contain an added ingredient that makes the traditional food functional (e.g. probiotic bacteria in a dairy product). These types of functional foods are similar in appearance to the conventional foods (beverage, food matrix), consumed as part of the

usual diet, which contains biologically active components with demonstrated physiological benefits, but fortified with other components as well.

Epidemiological studies have established a positive correlation between the intake of fruits and vegetables and prevention of diseases like atherosclerosis, cancer, diabetes, arthritis and also ageing (KAUR AND KAPOOR, 2001). Tomatoes and tomato products are known among the most appropriated functional foods, mainly because of their high antioxidant capacity (FUSCO ET AL., 2001, WILLCOX ET AL., 2004). The main color component of tomato is the phytochemical lycopene. Strong evidence exists for the role of lycopene in the reduction of prostate cancer, but it may also reduce the risk of certain other cancers through its inhibiting effect on cell proliferation. The risk of heart diseases might be reduced as well. Tomatoes are popular worldwide, the fourth most commonly consumed fresh vegetable and the most frequently consumed canned vegetable in the American diet. Many common foods contain tomato (fresh or canned tomatoes, dried tomato, tomato paste, ketchup, tomato soup, pizza or salsa).

Phenolic flavonoids, lycopene, carotenoids and antioxidant vitamins are among the most thoroughly studied antioxidants. As a powerful antioxidant, vitamin C (ascorbic acid) helps lessen oxidative stress to the body and is thought to lower cancer risk. Vitamin C ascorbic acid is essential for the growth and repair of tissues, development and maintenance of blood vessels and cartilage. Ascorbic acid is also necessary for creating ATP, peptide hormones, dopamine, and other essential compounds. It is still not known whether vitamin C contributes to these benefits directly (PADAYATTY ET AL, 2003). High vitamin C content foods include peppers, dark leafy greens, kiwis, broccoli, berries, citrus fruits, peas, and tomato is among the foods with the highest vitamin C content as well.

Another fact in vegetable and fruit consumption is that products with better nutritional properties are strongly promoted.

This way, environmentally friendly plant growing technologies, using natural organic material carriers, should certainly be advantageous.

Soil conditioners are used more often to improve soil structure, aeration and water retention. Some of them increase soil nutrient content, ion-exchange capacity, organic matter content and microbiological activity. Zeolite containing materials are permitted for using in ecological agricultural production. These materials have the ability of reversible hydration/dehydration process and increase nutrient retention, thus reduce environmental nutrient losses and fertilizer requirements.

Applied conditioners: Rioplant (containing natural rhyolite tufa; composition is patented) is a soil conditioner that protects plants from pests, diseases and other harmful environmental impacts resulting in physiologic abnormality. Plantafosz Universal (Cheminova) strengthens the natural defenses of plants, so the usage of pesticides is reduced, and also provides nutrients to the plants. Plantafosz stimulates the uptake of nutrients in the most intensively dividing plant parts in the intensive vegetative and reproductive growth stages, supporting nutrient uptake in this way. Plantafosz Universal is rapidly taken up by the plants through both the leaves and the roots. Zeon-A is natural plant conditioning material originating from zeolite enriched with natural sulphur.

The aim of our study was to investigate the result of the usage of soil and plant conditioning materials during the growing phases on physical status and crop mass of tomato. Another interesting question was to determine a potentially inducing effect of these substances on the production of phytoactive compounds, e. g. vitamin C levels in tomato fruit.

MATERIAL AND METHOD

In our examinations tomato was used as a test plant. Tomato cultivar 'Mobil' manufactured by the Vegetable Research Institute in Kecskemét was offered for field growing. Experiments were carried out in the study garden of our Faculty of Horticulture in 2012. The soil of the garden is sandy soil with low humus content, moderately filled up with N, P, K nutrients.
Tomato seedlings were planted in the end of May (29th May), in double rows; with 110+50 cm row spaces and 33 cm plant distances. This meant 3.78 plants/m^2.
In our study we applied 4 repetitions, in random block layout, with 30-30 plants in each repetition.

Plant conditional treatments took place between 15 May and 9 August. Five treatments were used as follows:

Treatment 1 – control: normal field growing (moderate NH_4NO_3 fertilizer use) without any conditioner.
Treatment 2 – 500 kg/ha Rioplant (thoroughly mixed into the soil before planting).
Treatment 3 – 500 kg/ha Rioplant (thoroughly mixed into the soil before planting) + Plantafosz Universal 4 L/ha spayed on the leaves every ten days, altogether in six cases.
Treatment 4 – 500 kg/ha Rioplant (thoroughly mixed into the soil before planting) + Zeon-A 4 L/ha spayed on the leaves every ten days, altogether in six cases.
Treatment 5 – 500 kg/ha Rioplant (thoroughly mixed into the soil before planting) + Plantafosz Universal 4 L/ha + Zeon-A 4 L/ha spayed on the leaves every ten days, altogether in six cases.

The growing phases, physical status, crop size and crop mass of tomato were determined in the different phases of the vegetation period.
Vitamin C levels in tomato crop harvested on 18 September were determined in the Soil and Plant Testing Laboratory of Faculty of Horticulture (Kecskemét College). Vitamin C content in tomato fruit was analyzed after water extraction by volumetric method following extraction described previously (CSERNI ET AL., 2007). The results were given in mg/100g fresh tomato fruit. Statistical analysis was made by Student's unpaired t-test.

RESULTS

The grown tomato plants seemed to be visually healthy but the extraordinary atmospheric drought set back the development of the plants in spite of watering. The initial flowering was very weak, and the ripening of the berries was stretched. First harvest was only in early August. Most crops were collected in September. Harvest was made in four times till middle of September. Most crops were collected in September. Harvesting data are shown in *Figure 1* and *Figure 2*.

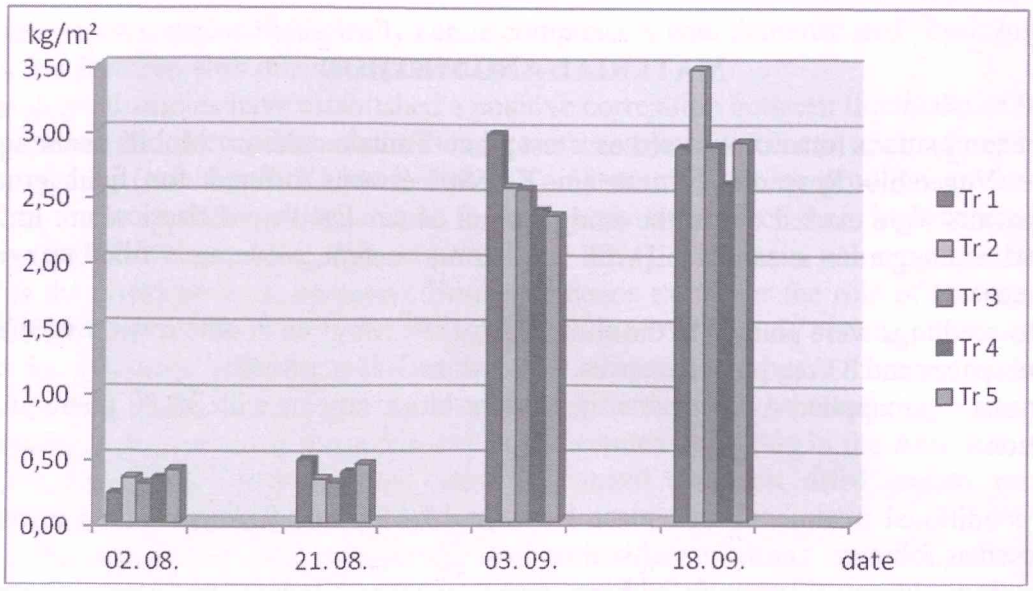

Figure 1. Crop mass (kg/m^2) in different phases of vegetation after different treatments (1 to 5)

Table 1. Total amount of harvested tomato fruit after treatments (1-5)

	Tr 1	Tr 2	Tr 3	Tr 4	Tr 5
Total crop (kg/m^2)	6.56	6.73	6.05	5.71	6.13

In our experiment we reached moderate yields. Total amount of tomato did not change after using the conditioning materials. The highest yields were reached after Treatment 2, but changes were not significant among the treatments in 95% level (*Table 1).*

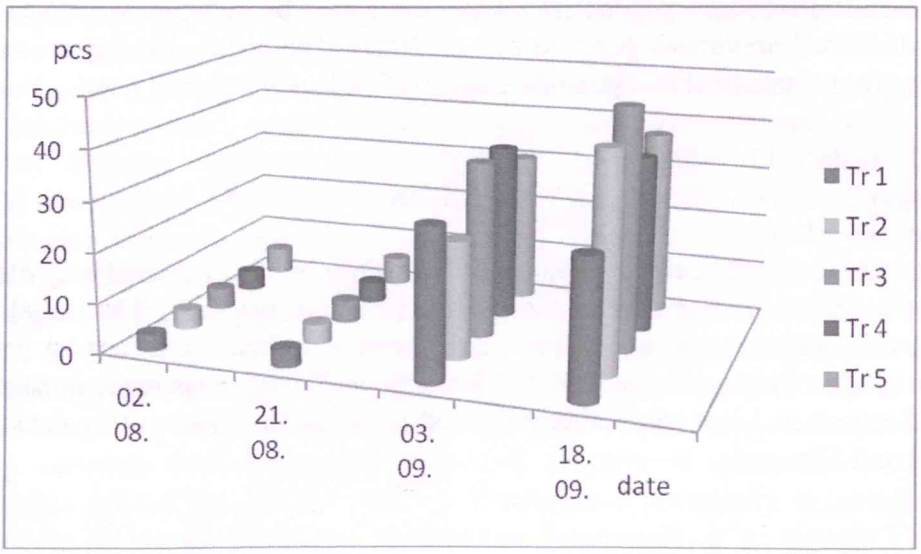

Figure 2. Pieces of tomato fruits/m^2 after treatments 1 to 5

As shown in *Figure 2*, most pieces of tomato fruits were harvested after Treatment 3 (91.8 pcs/m^2), followed by Treatment 4 and 5. In addition to the berry crop we tested average weights of fruits per treatment. The highest average fruit weight was obtained in the control treatment (109.6 g/berry). The smallest average fruit mass was obtained in the Treatment 3, nearly 66 g. In the other 3 treatments (2, 4, 5) the average berry weight ranged 76-90 g.
In the samples collected on 18th September vitamin C content was analyzed as well. The results are illustrated in *Table 2*. Increase in vitamin C concentration proved to be significant (level $p<0,05$; 5%).

Table 2. Changes in vitamin C levels in tomato after different treatments (1-5)

Treatment No	Vitamin C (mg/100 g)
1	16.38
2	20.95
3	28.36
4	21.49
5	25.19

CONCLUSIONS

Functional foods do not have an internationally agreed definition but they can be defined as foods that provide a health benefit beyond basic nutrition.
Tomato is one of the most common and favorite fruit all over the world. Investigations focused on the increase of the intake of specific functional foods showed that the vast majority of the participants intended to consume more tomatoes and tomato products (PELLETIER ET AL., 2002).
It can be said that the materials used in a plant production had positive effects on the treated plants the crop yield and resulted in increased fruit quantity as well. Both plant protection products applied to the plants positively influenced the vitamin C content of the tomato fruit. The values show that the control treatment had the lowest content of vitamin C, while each treatment raised it for various degrees. The highest vitamin C content was measured in Treatment 3 (28.36 mg / 100 g).
This test should be carried out and continued throughout the duration of the growing season for vitamin C content determination.

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REFERENCES

ASHWELL, M. (2001): Functional foods: a simple scheme for establishing the scientific basis for all claims. Public Health Nutrition 4: 859-863.

BABOOTA, R.K., BISHNOI, M., AMBALAM, P., KONDEPUDI, K.K., SARMA, S.M., BOPARAI, R.K., PODILI, K. (2013). Functional food ingredients for the management of obesity and associated co-morbidities – A review. Journal of Functional Foods 5(3): 997-1012.

CSERNI, I., BNÉ PETŐ, J., HÜVELY, A., RAJKAINÉ VÉGH, K., RAJKAI, K., SZILI-KOVÁCS, T., NÉMETH, T. (2007): Néhány beltartalmi érték alakulása paradicsom bogyóban különböző talajtípusokon különböző nitrogén ellátottság mellett, Proceedings of the 4th Erdei Ferenc Scientific Conference, pp. 232-235.

FUSCO, D., COLLOCA, G., LO MONACO, M.R., CESARI, M. (2007): Effects of antioxidant supplementation on the aging process. Journal of Clinical Interventions in Aging 2: 377-387.

KAUR, C., KAPOOR, H.C. (2001): Antioxidants in fruits and vegetables – the millennium's health. International Journal of Food Science & Technology 36(7): 703–725.

PADAYATTY, S.J., KATZ, A., WANG, Y., ECK, P., KWON, O., LEE, J.H., CHEN, S., CORPE, C., DUTTA, A., DUTTA, S.K., LEVINE, M. (2003): Vitamin C as an antioxidant: evaluation of its role in disease prevention. Journal of the American College of Nutrition 22(1): 18–35.

PELLETIER, S., KUNDRAT, S., HASLER, C. (2002): Effects of an educational program on intent to consume functional foods. Journal of American Diet Association 102: 1297-1300.

VAN KLEEF, H., VAN TRIJP, H.C.M., LUNING, P. (2005): Functional foods: health claim-food product compatibility and the impact of health claim framing on consumer evaluation. Appetite 44: 299-308.

WILLCOX, J., ASH, S., CATIGNANI, G. (2004): Antioxidants and prevention of chronic disease. Critical Reviews in Food Science Nutrition 44: 275-295.