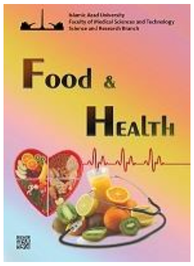
Food & Health 2021, 4(1): 5-9



Food & Health
Journal homepage: fh.srbiau.ac.ir
Journal

Investigation the impact of Ag nanoparticles of orange fruit's peel, chitosan and silamol treatment on tomato nutritional health content

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ARTICLE INFO

Original Article

Article history:
Received 12 January 2021
Revised 27 February 2021
Accepted 08 March 2021
Available online 20 March 2021

Keywords:
Nanoparticles
Chitosan
Silamol
Tomato
Nutritional content

ABSTRACT

Chemical methods to grow and improve plants threaten the health of the environment. In a previous study, factors assuming that flavonoids properties for instance pH, temperature, time, and plant extract content were assayed. Tomato (*Solanum lycopersicum*) is the second most important vegetable in the world in terms of its economic value. This experiment was conducted in a completely randomized block design with three levels of chitosan, sylamol, aqueous extract, and silver nanoparticles with three replications. Different concentrations of silver nitrate solution (10, 20, 30mg/ l), aqueous extract (10, 20, 30mg/ l), chitosan (0.1, 0.3, 0.5 v/v) and silamol (1/1000, 2/1000, 3/1000(v/v) and control treatment (distilled water) were applied. Nutritional content including lycopene, Total soluble solids concentration (TSS), vitamin C, zinc, iron, magnesium, phosphorus, calcium, and potassium. Factors assuming that flavonoids properties for instance pH, temperature, time, and plant extract content were assayed., Fe, Mn, P, Ca and K, are significantly affected by using treatment. Measurement of features was done at 4, 1, 3, 7, and 11 days. The results showed that the application of the above treatment at 30 ppm silver nanoparticles was more effective than all other nutritional characters. So, these natural matters could be used for increasing the quality of tomatoes.

1. Introduction

The tomato belongs to the Solanaceae family, which is the second most significant vegetable worldwide in terms of its economic worth. This vegetable was cultivated for 28.7% of the total vegetable crop area in Iran. Iran, however, has only about 3.4 percent of global tomato production, with 14 percent of global cultivation. Low yield along with the inappropriateness of harvesting, packing, and storage conditions is one of the most important factors in reducing nutritional production (1). Tomatoes are the major dietary source of the antioxidant lycopene, which has been linked to many health benefits, including reduced risk of heart disease and cancer. They are also a great source of vitamin C, potassium, folate, and vitamin K. Usually red when mature; tomatoes can also come in a variety of colors, including yellow, orange, green, and purple. What's more, many subspecies of tomatoes exist with different shapes and flavors. Tomato contains 94.5% water and its (approximate amount of) main nutritional substances are: Carbohydrate 3.9 g/100 g, vitamin C 12.7 mg/100 g, vitamin A 833 IU/100 g, and lycopene 2,573 µg/100 g with well-known anti-cancer properties. Vitamin C, available in tomato products, is necessary for the normal metabolic performance of the human body; besides, consumption of vitamin C assists us to resist cancer, improves our cholesterol level, and compensates for collagen shortage in our body (2). Orange peel is included outer and inner peel, which is considered as a suitable original of antioxidants, which has a high level of flavonoid (3). Also, orange peel mesocarp has reported the most antioxidant traits among the different orange in the north of Iran. Chitosan is a biodegradable compound derived from crustacean shells such as crabs and shrimp, the main feature of which is its polycotin content. It has been shown to promote improvement and

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growth before and post-harvesting horticultural products (4). Sylamol, with changes in the structure of leaf, stem, and root plants, results in complete photosynthesis, resistance to pests, and aerobic and soil pathogens (5). Tomato fruit has a restricted postharvest life due to its watery texture and high metabolism. Therefore, they might be losing their nutritional value. Up to 50 percent of agricultural products are destroying due to damage, annually, which can increase the postharvest life if new methods are applied. Considering that the tomato plant is strongly losses its quality and because of its post-harvest life, the results of this study can provide new methods for increasing the post-harvest life and nourishing attribute of tomatoes by using a natural product.

2. Materials and methods

In the previous experiment, the orange mesocarp has the remarkable ability as an original of natural bioactive flavonoids, so it was consumed to generate Ag ions. Factors assuming that flavonoids properties for instance pH, temperature, time, and plant extract content were assayed. The data were investigated by the UV-VIS. The attributes of the nanoparticles were measured using TEM, X-ray electron microscopy methods to describe the size and specific surface area of the particles. The total flavonoid substance was 45.06 mg/g of orange fruit's peel. Our finding indicated that the aqueous *Citrus sinensis* peel extract might be produced Ag^{2+} nanoparticles in 90 °C, pH: 8, 48 hours, and 20:80 content (6). Tomatoes were transferred from a greenhouse in Pakdasht to Tehran. The fruits were immersed in 1% sodium hypochlorite solution for 2 minutes, then rinsed with distilled water and dried to air. Subsequently, different concentrations of silver nitrate solution (10, 20, 30mg/ l), aqueous extract (10, 20, 30mg/ l), chitosan (0.1, 0.3, 0.5 v/v) and silamol (1/1000, 2/1000, 3/1000(v/v) and control treatment (distilled water) were applied. Total soluble solids concentration (TSS) of the juices extracts were determined by refractor meter. Fruit vitamin C was measured by titration with Potassium iodide and was calculated with the formula of Shafiee et al. (7), lycopene (8), Cu, Fe, Zn, P, Ca, Mn, and K were determined by Atomic absorption spectrometers (Varian-SpectrAA.200) (9). This research was done as a completely randomized design with three replicates. Duncan's test was used for mean comparison at 1%. All statistical analyses were calculated using SPSS 19 Statistical software and the graphs were drawn in Microsoft Office Excel 2013.

3. Results and discussion

Studies assumed that spraying of fruits and vegetables intended for storage with a solution containing silver ions would extend their shelf life, which this study tried to show by focusing on tomatoes. According to Table1, the effect of treatment was significant on lycopene at 1% level. The control group showed a statistically significant difference with other treatments. Control treatment with 9.01 µg/g, the lowest, and 30 ppm nanosilver has the highest lycopene (23.11 µg/g) (Fig. 1a). Data demonstrated that tomato lycopene enhanced during the time due to treatment. Various levels of treatments have a significant effect on TSS (Table 1).

Table 1. Analyze variance of traits.

SOV	DF	Zn	Fe	K	P	Cu	Mn	Vitamin C	TSS
Rep	2	0.05	0.08	0.7	0.8	0.22	0.04	0.04	0.09
Treatment	6	0.89*	13.54*	11.76*	10.85*	14.55*	10.13*	22.12**	33.01*
CV	-	10.2	8.56	12	13.9	25	10.7	10.7	11.5

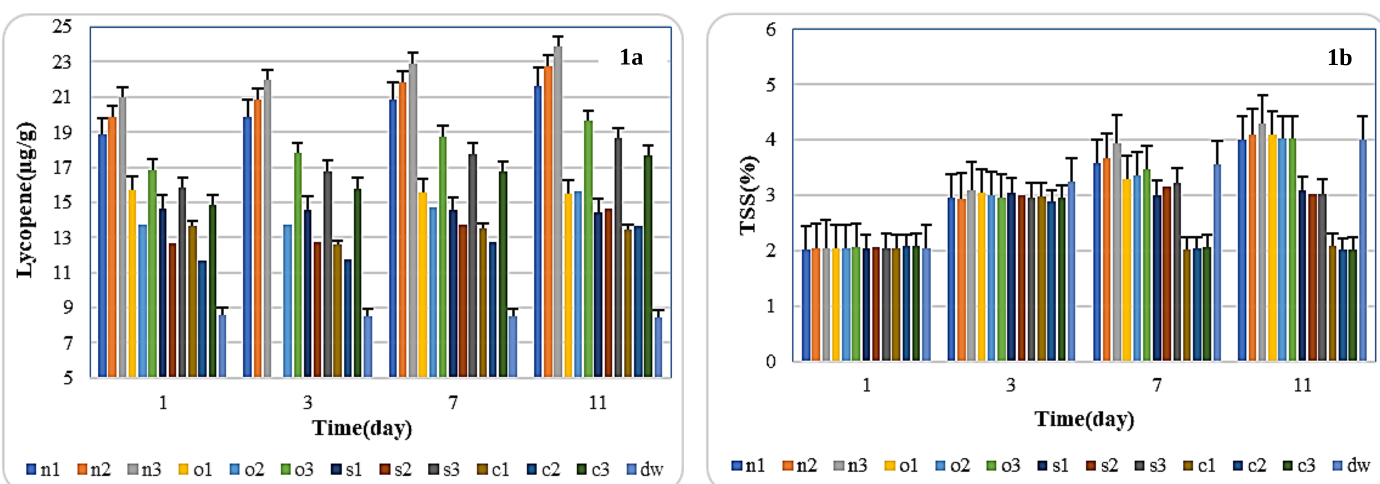

Fig. (1 a-b). Changes in lycopene and TSS supplemented with different treatment [error bar indicate standard deviation].

Maximum content belonged to plants sprayed by 30 ppm nanosilver (4.5 %) and lowest in control without any substance (2.1 %) (Fig. 1b). The rate of vitamin C was affected by all treatments. It reduced during the time but on the 11th day final its content was achieved through the same treatment by 30 ppm nanosilver (0.2 mg/100g ml) whereas the minimum volume was observed in control (0.05 mg/100g ml) (Fig. 2c). Similarly, the Zinc element in tomato treated with30 ppm nanosilver (9.8 mg/100 g F.W) was greater than other treatment; this was significantly different from the control, which averaged (7.3 mg/100 g F.W) (Fig. 2d). In this study, organic matter application, leads to the stimulation of Cupper, in 30 ppm nanosilver after 11days of storing (Fig. 3e). The smallest amount of Iron has associated with the control specimen of storage and the highest rate is the application of 30 ppm silver nanoparticles (0.22 mg/100 g F.W) (Fig. 3f).

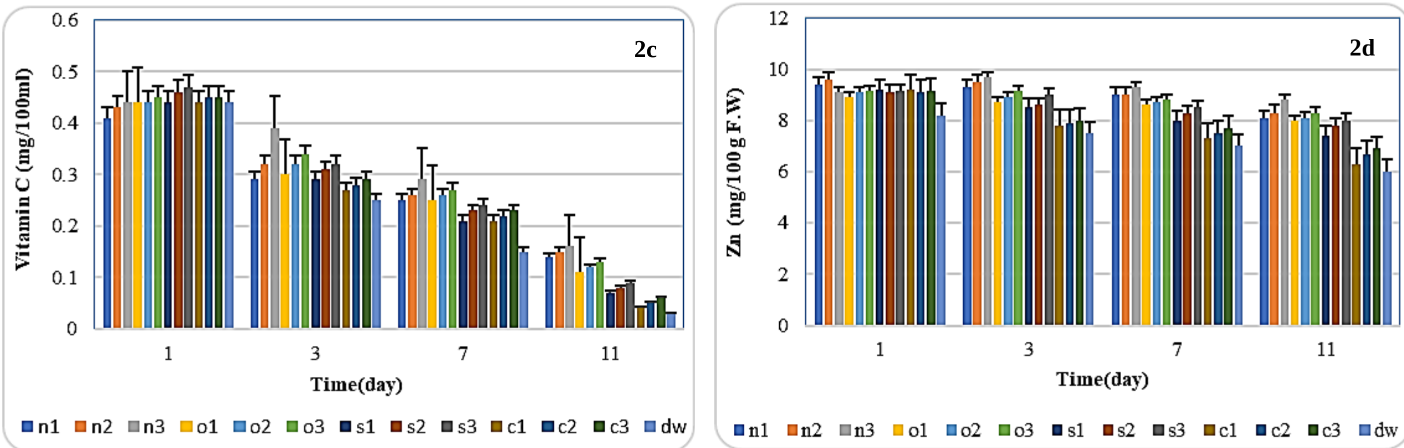

Fig. (2 c-d). Changes in vitamin C and Zn supplemented with different treatment [error bar indicate standard deviation].

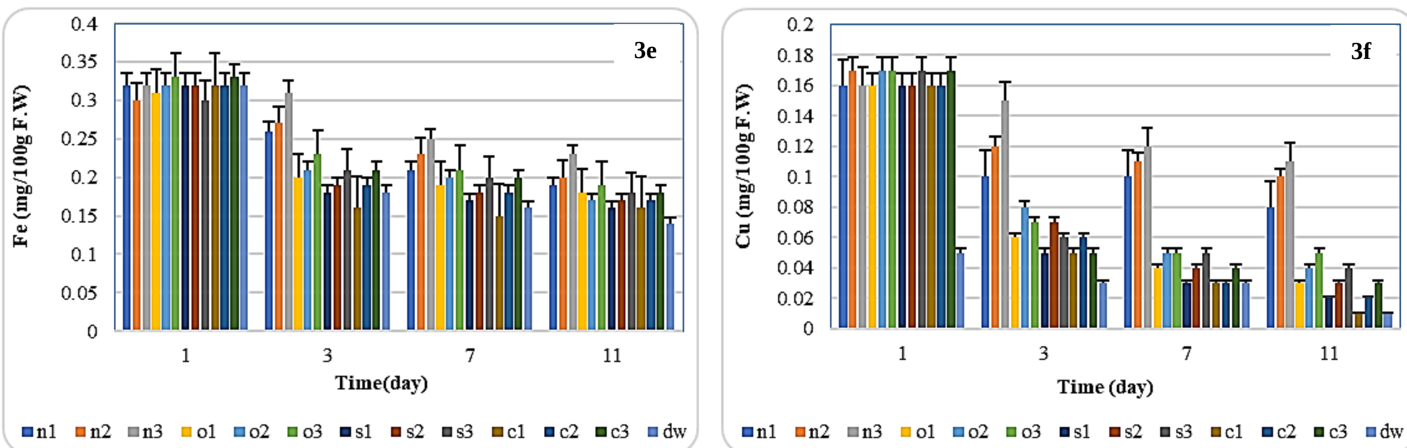

Fig. (3 e-f). Changes in vitamin Cu and Fe supplemented with different treatment [error bar indicate standard deviation].

In addition, the amount of Manganese in 30 ppm nanosilver treatment is higher than other treatments (0.21 mg/100g F.W) (Fig 4g). Comparison of the mean Phosphorous signed that the numerous (33 mg/100 g F.W) was displayed in same treatment and the minimum (23 mg/100 g F.W) was at control (Fig 4h). In nanosilver treatment groups, the highest Calcium trace was observed in the amount of (13.9 mg/100 g F.W) of 30 ppm and with the increase of day of storing, Ca content decreased. 30 increase in Potassium (249 mg/100 g F.W) compared with others (Fig. 5i). Tomato treated with 30 ppm nanosilver have higher potassium (4.26%) than plants in the other treatments (300 mg/100 g F.W) (Fig. 5j). Increasing demand for high-quality mangoes has increased the need for enhanced fruit quality and longer shelf life. The concentrations of minerals in fruit can affect its quality and shelf life and physicochemical composition. Mineral ions are of prime importance in determining the fruit's nutritional value. Our finding offered that treatment with various concentrations of all tested treatments had a beneficial affection on all evaluated values. The nutritional status treatments especially the treatment of nanosilver have significant results. Achievements of nanotechnology can be used at each stage of food production as well as in the production of fruits and vegetables (10). Spraying of tested tomatoes and fruits with a nanosilver water solution delayed almost twice the appearance of symptoms of their microbiological decay. Gopal et al. (11) investigated the effect of silver in relation to its concentration and the shelf life of freshly cut iceberg lettuce stored at the temperature of 12ºC. Silver generated from nitrates and silver generated electrochemically was taken into consideration. The authors showed that washing of salad with water mixed with silver as well as silver and hydrogen peroxide was more effective than washing with chlorinated water. According to obtained results, silver at 30 ppm caused a significant effect on a nutritional state already on the day of eleven. It is known that silver creates a strong bond with amino acids through ⁻SH (thiol), -NH2 (amino), -COOH (carboxylic), -C3H4N2 (imidazole), and -PO4 (phosphate) groups. The most important amino acid, which binds silver, is cysteine, thus it is this compound which while binding with ion silver causes a disturbance in the

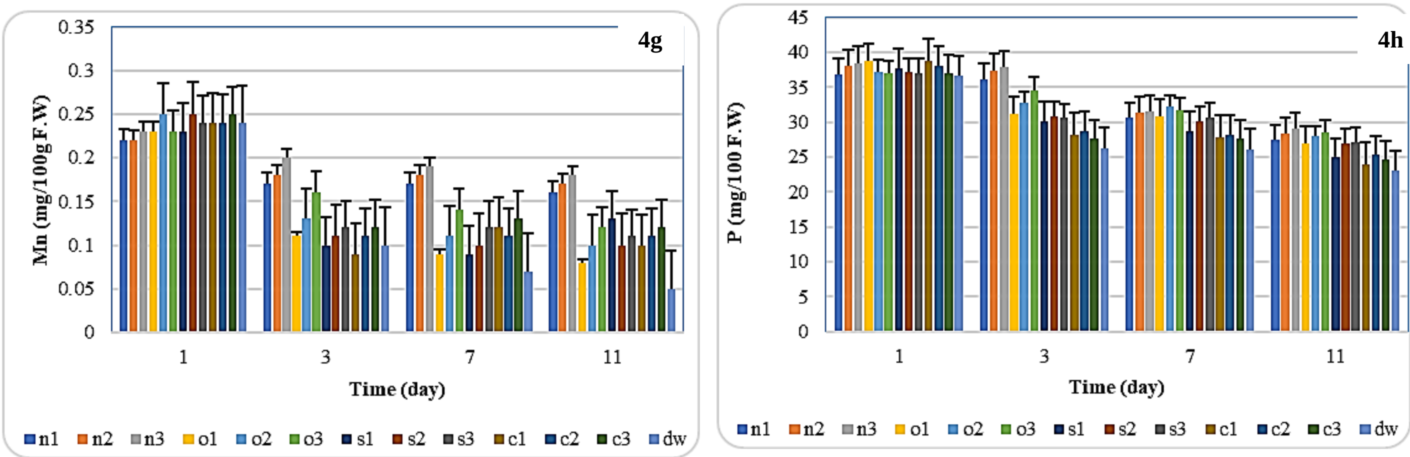

Fig. (4 g-h). Changes in vitamin Mn and P supplemented with different treatment [error bar indicate standard deviation]

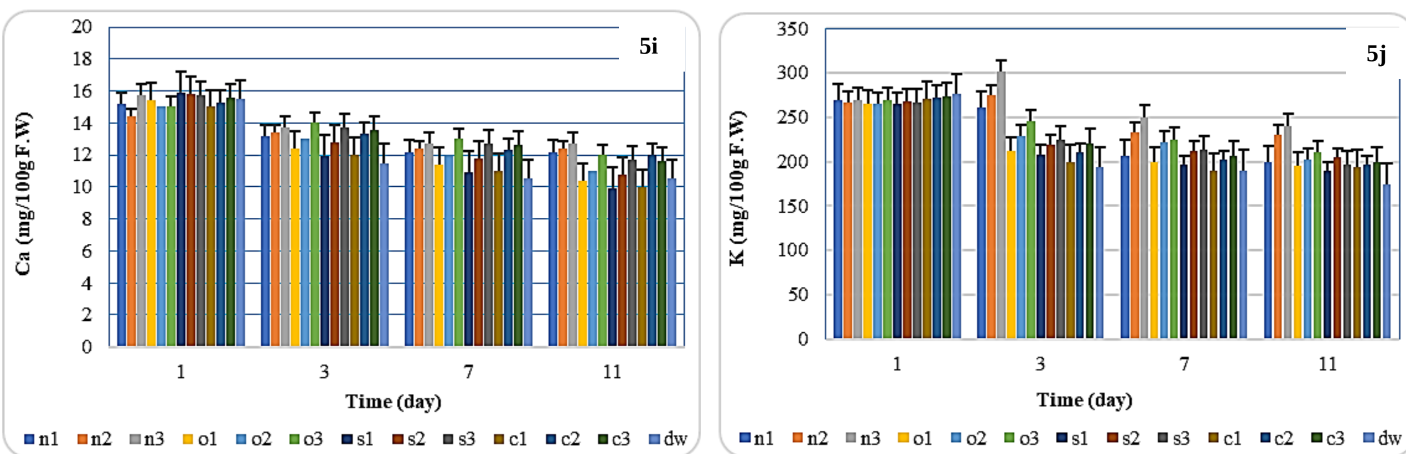

Fig. (5 i-j). Changes in vitamin Ca and K supplemented with different treatment [error bar indicate standard deviation].

metabolic pathway by which proteins are denatured and lose their biological activity (12). In consist with our finding, exposure of cowpea to nano-Cu treatments increased both the uptake and bioaccumulation of Cu and also promoted the activity of APX and GR in root and leaf tissues of cowpea (13). The degree of response of stress enzymes to nano-TiO2 was particle size. Fruit quality analysis indicated a decrease in Ca, Mg, and Fe contents that were particle size- and dose-dependent. In addition, the proximate composition (except carbohydrate) of fruits was all negatively altered by both nano-TiO2. The particle size is a factor in the phytotoxicity and the individual effect of both nano-TiO2 on the okra plant was dose-dependent (14). Silver nanoparticles on the shelf life of Valencia oranges were tested (15). It showed that different concentrations of silver nanoparticles had a positive effect on maintaining fruit freshness and vitamin C content, also when the concentration of silver nanoparticles enhanced, vitamin C would be changed. Potassium significantly improves the amount of soluble solids, vitamin C, color, phenolic compounds concentration, taste, and firmness of the fruit. Potassium content notably depends on the concentration of pigments such as lycopene and beta-beaco (16). Some researchers achieved similar results about elements and another national status which was agreed with our results (17).

4. Conclusion

Conclusively, the results suggest that natural material with different concentrations had a positive impact on all evaluated nutritional states. By enhancing the concentration of silver nanosilver, a better result was achieved. . So, these natural matters could be used for increasing the quality of tomato.

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