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STUDY OF THE EFFECT OF SOME TREATMENTS AND METHOD OF DRYING ON THE STORING AND QUALITATIVE CHARACTERISTICS OF TOMATO VARTIETY KANZE

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Abstract

This study was conducted in one of the private plantation in Diyala Governorate \Iraq for the 2019 season and physiology laboratory of fruits after harvest in department of Horticulture and Gardening landscape, College of Agriculture, Diyala University on tomato hybrid Kanze, The aim was to know the effect of pre-harvest treatments, which included; First Factor: Spraying plants with the amino acid Arginine at a concentration of 150 $mg.L^{-1}$, Calcium Chloride 20 $g.L^{-1}$ and distilled water only as a Control treatment on some of the chemical properties of powdered dried tomato fruits in two ways. The second factor : the natural solar drying and drying by the electric oven and the interaction between them and three replicates, the results showed: 1-The treatments of spraying with calcium chloride and arginine acid were superior in increasing the fruit powder content of beta-carotene pigment, and the treatment of spraying with calcium chloride was superior significantly in raising the nitrogen and protein content of tomato powder, the treatment of arginine acid spray significantly affected in raising the pH of fruit powder. We note that the superiority of spraying treatments was not significant in increasing the proportion of Lycopene pigment and the proportion of arginine acid. 2- The Control treatment excelled in giving it the highest vitamin C content and reducing the coloration of tomato fruit powder to 816 NTU. 3- There was no significant effect of the study treatments on the percentage of weight loss and the fruit powder content of calcium ppm, and the drying methods did not have a significant effect on the content of tomato fruit powder from beta-carotene and the percentage of arginine acid and pH. 4- The solar drying gave the highest content of lycopene and vitamin C, while the drying with Oven gave the highest nitrogen and protein ratio 0.240%, 1.500% in respectively, and the brown coloration of the dried fruit powder was reduced to 123 NTU.

Keywords: Tomato, arginine, calcium chloride, drying.

Introduction

The tomato *Lycopersicum esculantum* Mill, which belongs to the Solanaceae family, is an important vegetable crop in our daily food because it is one of the crops rich in phenols and flavonoids that contribute to inhibiting free radicals in the human body and antioxidants such as Lycopene and Ascorbic acid (Giovanelli and Paradiso, 2002).It helps prevent cancers and heart diseases (Lister, 2003), World tomato production has doubled 300% in the last three decades, reaching 125 million tons (Haji Ali *et al.*, 2010). Tomato is characterized by the speed of damage after ripening and its short storing life and by the speed of its damage in the markets, so resorting to drying is an important way to preserve it (Lewicki, 2005). Water is removed from fruits and vegetables, including tomato, to less than 20% of its weight, to raise the concentration of solid materials sufficiently to inhibit the factors of corruption (microbes - enzymes - chemical reactions) while preserving as much of the natural and biochemical properties as possible, It takes advantage of the sun's heat and other heating methods such as hot air and micro waive drying in recent years, and drying greatly reduces the cost of storage, packaging and transportation (Nijhuis *et al.*, 1998). Tomatoes are cut, dried or ground in powder form and preserved for use when needed in many areas of the food industry, where they can be dried in the form of halves, slices or soft powdered powders, for use as a component of pizza or returned to sauce and for different vegetable dishes (Giovanelli *et al.*, 2002) However, the higher the drying temperature and the longer the drying time, the greater loss of ascorbic acid and Lycopene, While the lower the drying temperature, the less it will be lost (Kross *et al.*, 2004). The high drying temperature reduces nutritional value, smell and flavor and increases the hardening of the outer shell and the optimum drying temperature is 45-55 °C. which allows keep the vitamins and Lycopene who responsible for dark red color and Flavor Preservation (Lund and Freeston, 2001). Calcium salts, including calcium chloride, were used to reduce fruit damage and increase their total acidity and vitamin C content (Lee and Kader, 2000). The main objective of the drying process of fruits and vegetables is to reduce their moisture content to the extent that allows prolonging the storage period and preserving them from biological deterioration processes, as well as reducing shipping and packaging costs as a result of low weight and ensuring that they provided outside the production season and its consumption as alternatives to fresh fruits. In addition to determining the qualitative and chemical characteristics after drying and grinding tomato fruits and storing them, then the possibility of re-converting them into tomato paste by studying the following factors:

1-The effect of amino acid (arginine) and calcium chloride on drying tomato fruits.

2-The effect of drying methods on the nutritional components of dried tomato fruits.

Materials and Methods

This study was conducted in one of the private plantation in Diyala Governorate\Iraq for the 2019 season and physiology laboratory of fruits after harvest in department of Horticulture and Gardening landscape, College of Agriculture, Diyala University on tomato hybrid Kanze, Approved in Iraq and produced by the French company Vilmorin, It is an indeterminate growing hybrid, the color of the fruits is red, good toughness, oblong fruits, which are faster in drying than round fruits, Seedlings were produced inside a greenhouse after planting seeds in 75-eye plastic dishes on 12/15/2018, The seedlings were planted in the greenhouse after reaching the stage 4-5 real leaves on 15-2-

2019 after preparing the greenhouse soil with dimensions (36m length x 5m width). The soil was prepared by a plow, the cultivation was on terraces, on the two sides of the terrace, and the distance between one plant to another is 40 cm, the length of the cultivation line is 30 m, and the number of cultivation lines is 6 lines, where the experimental unit area reached 5.7×7.0m. Recommended processing for planting including irrigation, weed control, insect and fungal infections control and crop harvesting were provided until the end of the season. Plants spraying operations were carried out in the early morning after watering the plastic house one day before spraying, to help open the stomata, increase the absorption process, to reduce the surface tension of the water, to ensure complete wetness of the leaves and increase the efficiency of the spray solution to penetrate the outer surface of the leaf. The plants were sprayed on three stages, the first after 70 days of planting and the second 10 days after the first, and so on for the third spray, the concentrations are as follows:

Spray the plants with the amino acid Arginine $C_6H_{14}N_4O_2$ at a concentration of 150 mg.L^{-1} 1- Spray the plants with $CaCl_2$ at a concentration of 20 mg.L^{-1}

2- Plants sprayed with distilled water only as a Control treatment.

The fruits were harvested at the full coloring stage in red on 1/6/2019. After the sorting process, the fruits were stored in the refrigerator for a week and then followed by two days at the laboratory temperature as a marketing period where the fruits reached a full ripening stage, with what is appropriate to display the tomato crop in the market and deal with it on the basis of surplus fruits from the market and its destiny is spoilage and to benefit from it and avoid spoilage the following has been done:

Each fruit was cut into 5 mm thick slices and placed in two-layer trays. The sliced tomato slices were divided into two parts:

1- **The first part:** is naturally dried under direct sunlight for a period of time until the moisture percentage is reduced by 20-25% until the weight is fixed.

2- **The second part:** Dry it in an electric oven at a temperature of 50 °C until the weight is fixed.

After dry storage of tomato powder, it was converted into tomato paste material by adding 100% water to it and mixing it in the mixer for five minutes and leaving it to completely dissolve and turn into tomato paste material. The field experiment and drying were carried out using Complete Randomized Design (C.R.D.) with three treatments and three replicates, the averages were compared by using the L.S.D significant difference test at a probability level of 0.05 (Alrawi and Khalaf Allah, 2000). The following measurements were made:

1- **Weight loss percentage**: calculated according to the following formula:

$$\text{Weight loss percentage} = \frac{\text{Weigh the fruits before drying} - \text{Weigh the fruits after drying}}{\text{Weigh the fruits before drying}} \times 100$$

2- Fruit powder content of calcium (ppm): The calcium tomato powder content was estimated by using the Absorption Flame Emission Atomic Spectrophotometer supplied by Shimadzo 680 Japan, according to the method reported by (Richard and Jack, 1992).

3- Plant pigments (Lycopene and beta-carotene) (mg. 100 gm^{-1} fresh weight): The plant pigments were estimated according to the method mentioned by Delia (2001) using the Spectrophotometer.

4- The ratio of Arginine acid in tomato powder: estimated on the basis of nitrogen using the Kildal method. The percentage of arginine acid was calculated by multiplying the total nitrogen ratio by the constant (2.3) according (Gerhardt, 2010).

5- Fruits content of Vitamin C (mg. 100 g^{-1} dry matter): measured with pigment 2,6 Dichloro Phenol endo Phenol and calculated according to the (Ranganna, 1977).

6- Nitrogen Ratio (%): Total nitrogen was estimated by using the Micro Kjeldhahl apparatus, according to the Stem distillation method as described by (Ryan and Rashid, 2002).

7- Protein Ratio (%): The protein ratio was calculated from Multiply the result of the nitrogen ratio in the constant (25.6).

8- pH: It was measured with a pH meter.

9- The color degree: The color was measured by extracting 1 g of the sample with 200 ml distilled water by using an electric mixer, and the absorption read was on wavelength (320nm) by the spectrometer as shown in the method of (Salem and Hejazi,1972). Statistical analysis of dried samples was performed using Complete Randomized Design (C.R.D) with two factors: the first spray (control, arginine, calcium chloride) and the second drying method (solar, oven) and interaction between them and three replicates. The results were analyzed using the analysis of variance table and the results were compared using LSD test at the level of Probability 0.05 (Alrawi and Khalaf Allah, 2000).

Results and Discussion

Weight loss percentage:

The results of Table (1) showed that there were no significant differences in the percentage of weight loss among the study treatments. As for the effect of drying methods on the percentage of weight loss, no significant differences were recorded among them. No significant differences were observed between the study treatments and the drying method.

Fruit powder content of calcium (ppm): The results of Table (2) indicate that there were no significant differences between the treatments in the content of dried tomato powder from calcium and the two methods of drying did not significantly affect the tomato powder content of calcium, As for the interaction between the treatments and the drying method, it was significant, as the interaction treatment between the spray treatment with calcium chloride with the drying method with Oven gave the highest calcium content of 0.036 ppm, while the lowest calcium content was the interaction between the control treatment and drying treatment with Oven reached 0.021 ppm.

Plant pigments (Lycopene and beta-carotene) (mg. 100 gm^{-1} fresh weight):

From the results of Tables 3 and 4. The spray treatment with arginine amino acid gave the highest Lycopene content after drying and with no significant difference from Control,

which was 13.315 mg. 100 g^{-1} dry weight, Whereas, the calcium chloride and arginine acid spray treatments gave the highest beta-carotene pigment content after drying, with a significant difference from Control, which was 17.360 and 14.720 mg. gm^{-1} dry weight respectively. About the methods of drying, the results of the two tables above showed significant differences in the content of tomato powder from plant pigments, as solar drying gave the highest content of Lycopene, which reached 14.163 mg. gm^{-1} dry weight. However, no significant differences were observed between the two drying methods in the tomato powder content of beta-carotene. As for the effect of interaction between spraying treatments and drying methods on the tomato powder content of Lycopene pigment, the interaction treatment between Control treatment with solar drying was outperformed in its Lycopene content and recorded 16.550 mg. gm^{-1} dry weight. Whereas, the lowest Lycopene pigment content was 5.300 mg. gm^{-1} dry weight in the treatment of interaction between Control treatment and drying by oven. The mean of interaction between spraying treatments and drying methods differed in the content of tomato powder from beta carotene between them significantly, as the interaction treatment for spraying with calcium chloride and drying by Oven gave the highest beta carotene content as it reached 18.980 mg. gm^{-1} dry weight, while it recorded the Control (without spraying) with drying by Oven the lowest beta-carotene content was 8.680 mg. gm^{-1} dry weight. The reason for the results obtained from increasing the beta-carotene pigment when spraying tomato fruits with arginine acid may be due to the entry of amino acids in the formation of proteins and enzymes, and they control the maturity process and that the enzymes form the strength of the fruits and the formation of sugar and give color and smell (Hass, 1975). Or it may be attributed when spraying tomato fruits with calcium chloride due to the accumulation of calcium in the fruits as a result of drinking part of this salt, and as a result of the accumulation of calcium in the pulp of the fruit and its effect on the processes of ethylene and ripening and in some cases reducing CO_2 production (Luan *et al.*, 2002). The reason why the sun-dried fruit powder retains the highest Lycopene content is due to the role of solar drying in reducing the breakdown of Lycopene during drying (Camargo *et al.*, 2004).

The ratio of Arginine acid in tomato powder

From the results of Table 5, it is noticed that the spraying treatments differed significantly between them, but they did not differ from the Control treatment. The highest in the treatment of calcium chloride spray was 0.800%, and the lowest in the treatment of arginine spray was 0.664%. In Table 5 we found no significant differences between the drying methods (solar, Oven) in the fruit powder content of arginine acid. Significant differences were obtained from the interaction between arginine acid and calcium chloride spray and drying methods, as spraying with calcium chloride for drying by Oven gave the highest value of the arginine ratio was 0.832%, while arginine acid and solar drying gave the lowest value to the arginine ratio It was 0.624%.

Fruits content of Vitamin C (mg. 100 g^{-1} dry matter)

It is clear from the results of Table 6 that the control treatment and the treatment of calcium chloride spray were significantly superior in the content of dried fruit powder of vitamin C over the treatment of the amino acid as it gave 48.840 and 48.025 mg. 100 g^{-1} dry matter respectively, while they did not differ significantly between them. While solar drying maintained the highest vitamin C content, with a significant difference from drying by Oven as it reached 45.900 mg. 100 g^{-1} dry matter. The interaction treatment between the Control treatment (sprayed with distilled water only) and solar drying with the highest vitamin content reached 68.720 mg. 100 g^{-1} dry matter and a significant difference from the interaction treatment between the treatment of arginine acid and solar drying, which recorded the lowest vitamin content of 22.700 mg. 100 g^{-1} dry matter. The retention of tomato fruit powder with a higher content of vitamin C during solar drying may be due to the time period during which the tomato slices are exposed to high temperature is less when using solar drying than when using Oven, which leads to reducing the loss of vitamin C from the tomato fruit slices and this is consistent With what Hamid (1983) found when using solar energy to dry apricots and grapes.

Nitrogen Ratio (%)

Table (7) shows that the treatment of calcium chloride spray was significantly superior in raising the tomato powder content of nitrogen compared to the control treatment where it reached 0.240%, and did not differ significantly from spraying with arginine acid. Oven drying recorded the highest nitrogen ratio, with a significant difference from sun drying, which was 0.240%. The interaction treatment between the spray treatments before harvest and the drying methods was significant, the calcium chloride spray with drying by Oven gave the highest values was 0.260%, and the distilled water (Control) for solar drying gave the lowest values was 0.195%.

Protein Ratio (%)

The results of table 8 indicate the effect of spraying with calcium chloride, arginine amino acid, drying methods and their interaction in the protein content of tomato fruit. the results showed that the treatment of calcium chloride spray was significantly superior, which gave the highest rate of 1.500% over the Control treatment, which gave the lowest rate of 1.359% in the tomato powder content of protein, and did not differ significantly from the treatment of amino acid spray. About the effect of drying, drying by Oven significantly outperformed sun drying, recording the highest protein ratio of 1.500%, and solar drying recorded the lowest protein percentage of 1.362%. As for the effect of the interaction between spraying treatments and drying methods, the treatment of calcium chloride spraying for drying by Oven was significantly superior and gave the highest percentage of 1.625%, while the treatment of distilled water only (Control) to solar drying gave the lowest percentage of 1.218%.

pH

The results of Table 9 show the effect of some spraying treatments, drying methods and their interaction on the pH dried tomato fruit content, the results of this study showed that the treatment of spray with arginine acid significantly affected on the fruit powder content of pH and recorded the highest pH content of 4.725, with a significant difference from the treatment of spraying with distilled water and spraying with calcium chloride which was 4.545 and 4.325 respectively.

Also, this study showed that there were no significant differences between the two drying methods in the fruit powder content of pH. As for the interaction between the spraying treatments and the two drying methods, Table 9 shows that the highest pH value recorded in the treatment of arginine acid with solar drying was 4.830, while the lowest pH value was recorded when spraying with calcium chloride and drying by the Oven was 4.320. The reason for the high pH of the dried fruit powder as a result of spraying the arginine acid before harvest may be due to the absorption of amino acids and their conversion into organic acids while carrying out the vital activities of live cells, which are dissolved in the fruit juice, so the percentage of their nutritional components increases and then the pH increases (Pandita and Bhatnagar, 1981).

The color degree

Table 10 shows the effect of spray treatments, drying methods and their interaction in the color degree of dried tomato powder, Where the treatment of spraying with distilled water reduced the coloration of tomato fruit powder significantly to 816 NTU, followed by the treatment of amino acid which registered NTU 1034, and then the treatment of spraying with calcium chloride 1279.5 NTU. About the methods of drying, the effect was significant, as drying by Oven reduced the brown coloration of dried fruit powder to 123 NTU, while solar drying increased the degree of brown coloration of dried fruit powder to 856.3 NTU. As for the interaction between the study factors, the differences were significant as the Control treatment (spraying with distilled water only) for solar drying reduced the brown coloration of the tomato fruit powder and it was 501 NTU. The highest degree of discoloration in tomato fruit powder which was 1298 NTU for treatment with calcium chloride spray for drying with Oven. The reason for the decrease in brown coloration when drying fruits with Oven may be due to controlling the temperature used for drying when using Oven, In the case of natural (solar) drying, the food is exposed to the sun directly, which leads to a significant increase in the temperature of the food due to the concentration of solar radiation on it, which leads to Maillard reactions and the poor color of the dried food in this way, as it gains moisture from the air during the night.

Table 1 : Effect of some treatments, drying methods and their interaction on the percentage loss of weight of tomato fruits

B Treatment / Drying A	Spraying treatments			Average drying
	Cont.	Arginine acid	$CaCl_2$	
Solar drying	90.500	91.080	90.170	90.583
Oven drying	90.110	90.510	88.080	89.567
Average spray	90.305	90.795	89.125	
L.S.D	B factor N.S. Interaction N.S. A factor N.S.			

Table 2 : Effect of some treatments, drying methods and their interaction on the fruit powder content of calcium (ppm)

B Treatment / Drying A	Spraying treatments			Average drying
	Cont.	Arginine acid	$CaCl_2$	
Solar drying	0.026	0.032	0.023	0.027
Oven drying	0.021	0.023	0.036	0.027
Average spray	0.024	0.028	0.030	
L.S.D	B factor N.S. Interaction 0.011 A factor N.S.			

Table 3 : Effect of some treatments, drying methods and their interaction on the tomato powder content of Lycopene(mg\ gm^{-1} dry weight)

B Treatment / Drying A	Spraying treatments			Average drying
	Cont.	Arginine acid	$CaCl_2$	
Solar drying	16.550	13.300	12.640	14.163
Oven drying	5.300	13.330	5.910	8.180
Average spray	10.925	13.315	9.275	
L.S.D	B factor 2.516 Interaction 3.558 A factor 2.054			

Table 4 : Effect of some treatments, drying methods and their interaction on the tomato powder content of beta-carotene pigment (mg\ gm^{-1} fresh weight)

B Treatment / Drying A	Spraying treatments			Average drying
	Cont.	Arginine acid	$CaCl_2$	
Solar drying	**10.190**	15.740	15.740	13.890
Oven drying	8.680	13.700	18.980	13.787
Average spray	9.435	14.720	17.360	
L.S.D	B factor 2.516 Interaction 3.558 A factor N.S.			

Table 5 : Effect of some treatments, drying methods and their interaction on the content of tomato powder of arginine acid (%)

B Treatment / Drying A	Spraying treatments			Average drying
	Cont.	Arginine acid	$CaCl_2$	
Solar drying	0.765	0.624	0.768	0.719
Oven drying	0.736	0.704	0.832	0.757
Average spray	0.751	0.664	0.800	
L.S.D	B factor 0.126 Interaction 0.178 A factor N.S.			

Table 6 : Effect of some treatments, drying methods and their interaction on the tomato fruit powder content of vitamin C (mg. 100 g^{-1} dry matter)

B Treatment / Drying A	Spraying treatments			Average drying
	Cont.	Arginine acid	$CaCl_2$	
Solar drying	68.720	22.700	46.280	45.900
Oven drying	28.960	46.280	49.770	41.670
Average spray	48.840	34.490	48.025	
L.S.D	B factor 3.774 Interaction 5.337 A factor 3.081			

Table 7 : Effect of some treatments, drying methods and their interaction on the Tomato fruit content of nitrogen (%)

B Treatment / Drying A	Spraying treatments			Average drying
	Cont.	Arginine acid	$CaCl_2$	
Solar drying	0.195	0.239	0.220	0.218
Oven drying	0.240	0.220	0.260	0.240
Average spray	0.218	0.230	0.240	
L.S.D	B factor 0.013 Interaction 0.018 A factor 0.010			

Table 8 : Effect of some treatments, drying methods and their interaction on the tomato fruit content of protein (%)

B Treatment / Drying A	Spraying treatments			Average drying
	Cont.	Arginine acid	$CaCl_2$	
Solar drying	1.218	1.493	1.375	1.362
Oven drying	1.500	1.375	1.625	1.500
Average spray	1.359	1.434	1.500	
L.S.D	B factor 0.126 Interaction 0.178 A factor 0.103			

Table 9 : Effect of some treatments, drying methods and their interaction on the tomato fruit powder content of pH

B Treatment / Drying A	Spraying treatments			Average drying
	Cont.	Arginine acid	$CaCl_2$	
Solar drying	4.550	4.830	4.330	4.570
Oven drying	4.540	4.620	4.320	4.493
Average spray	4.545	4.725	4.325	
L.S.D	B factor 0.126 Interaction 0.178 A factor N.S.			

Table 10 : Effect of some treatments, drying methods and their interaction on the NTU color of dried tomato fruit powder.

B Treatment / Drying A	Spraying treatments			Average drying
	Cont.	Arginine acid	$CaCl_2$	
Solar drying	501	807	1261	856.3
Oven drying	1131	1261	1298	123
Average spray	816	1034	1279.5	
L.S.D	B factor 12.579 Interaction 17.790 A factor 10.271			

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