# ANTIOXIDANT ACTIVITY, LYCOPENE CONTENT AND TOTAL PHENOLICS OF HOME GARDEN TOMATO *(Solanum Lycopersicum* L.*)*

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## RESUMEN:

Jitomates de la variedad Saladette fueron cultivados en un huerto familiar de la ciudad de Zacatecas a partir de semilla comercial "Rancho Los Molinos" (CST) y mediante la semilla extraída de otro jitomate (EST). La actividad antioxidante (método ABTS+), el contenido en ácido ascórbico, la acidez total, el contenido en licopeno así como el contenido fenólico total de los tomates fueron analizados para ambos tipos de jitomate cultivado en el huerto, así como un jitomate adquirido en un supermercado (CT). El análisis de la varianza (ANOVA) mostró diferencias estadísticamente significativas ($P<0.05$) entre los tres tipos de jitomates analizados, excepto en la actividad antioxidante; siendo el tomate ETS quien presentó los valores más elevados en todos los demás parámetros. El Jitomate ETS presentó un 34% más de licopeno que el jitomate CT mientras que frente al jitomate CST una diferencia de 40%.

## ABSTRACT:

Saladette variety tomatoes were grown in a home garden of Zacatecas city from commercial seed "Rancho Los Molinos" (CST) and by another seed extracted from tomato (EST). The antioxidant capacity (ABTS+ method), ascorbic acid content, titratable acidity, lycopene and phenolic compounds were analyzed for both types of tomatoes (EST AND CST) grown in the homegarden as well as a tomato acquired in a supermarket of tomato. The analysis of variance (ANOVA) showed statistically significant differences ($P<0.05$) between tomato varieties analyzed, except for the antioxidant activity; being EST tomato who showed the highest values for all other parameters. ETS tomato showed a 34% more lycopene than CT , while against the CST tomato a difference of 40%.

**Palabras clave:** Compuestos bioactivos, Jitomate, Huerto.
**Keywords**: Bioactive compounds, tomato, homegarden.
**Área:** Alimentos Funcionales

## INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is one of the most consumed vegetables in the world, as fresh and in processed form. It is an integral part of diet worldwide and an important component in the Mediterranean diet. It is widely commonly available in various processed products such as puree, paste, whole peeled tomatoes, diced products, juice, sauces and soups (Charanjit et al. 2103, Lenucci et al 2006). Fresh tomatoes and tomato products are a rich source of bioactive compounds, including carotenes (lycopene, b- carotene), ascorbic acid, tocopherol, and phenolic

compounds (Charanjit et al., 2013). They are a major source of antioxidant, contributing to the daily intake of a significant amount of these molecules (Pinela et al., 2012). In this way, its consumption is strongly associated with a reduced risk of chronic degenerative diseases (Pinela et al. 2012). Consumers are becoming increasingly concerned about how, where and when foods are produced. This has led that the population wants to produce their own food.

Agronomic practices have been recognized as a critical factor in determining the nutritional quality of crops (Barrett et al., 2007). Levels of bioactive food compounds in fresh tomatoes can be affected by many pre- and postharvest factors such as cultivar, ripening stage at harvest and agricultural techniques (Dumas et al., 2003). Therefore, the purpose of this study was to analyze the antioxidant capacity, lycopene content and total phenolics of homegarden tomatoes.

## MATERIAL AND METHODS

### Raw Material

Commercial tomatoes (*Solanum lycopersicum* L. Saladet variety) were purchased in a supermarket in the city of Zacatecas, which were selected with similar characteristics in size, fresh appearance, characteristic red colour, maturity, firmly and without signs of shock.

To obtain home EST tomatoes in the homegarden, seeds of a commercial tomato were extracted, then washed with deionized water to remove the placental mucilage that covers them. Then, seeds were dried under conditions of sun and shade at intervals of 3 hours for each condition.

Dry seeds were sown (depth of 2-3 mm to prevent seed rot) in seedbeds made with plastic bags which were irrigated with 10 mL of water by syringe. When tomato seedlings reached 15 cm of height was transplanted in an open field with spacing of approximately 80 cm within row. Harvest was made when tomatoes reached an homogeneous characteristic red colour (after six months).

Also, saladette tomato seeds, brand "Rancho Los Molinos" were sown and maintained under the same conditions as the EST tomatoes. The compost used was made from organic waste (dry leaves, peel of vegetables and fruits, except citrus) to prevent acidification of cropland. Subsequently was combined with river soil and mezquite in a 1: 1: 1 relation. The mixture was sterilized with boiling water, allowed to cool, and then the seeds were sown.

### Chemicals and reagents

Gallic Acid, Folin-Ciocalteau's phenol reagent; ABTS (2,2-Azinobis (3-ethylbenzothiazoline-6-sulfonic acid)diammonium salt) 6-hydroxy-2,5,7,8-tetramethylchromane-2 carboxylic acid (Trolox), potassium persulphate, Butylated hydroxytoluene (BHT) and sodium carbonate were purchased from Sigma Chemical Co. (St. Louis, MO, USA); ethanol, n-hexane and methanol were HPLC-grade (JT Baker, USA).

**Analysis**

Moisture content was determined according with the 950.46 AOAC method (1997). Solid soluble content of tomatoes was expressed by the Brix of fresh juice. The measeurement was taken by placing a drop of juice on the prism of a refractometer. The pH was carried out on the juice obtained from homogeniezed tomatoes using a pH-meter. Total acidity was estimated by tritration according with 942.15 AOAC method (1997) and results were expressed as citric acid milligrams. From total acidity and Brix, maturity index was determined. Analysis of the content of ascorbic acid (AA) was carried out by the method described by AOAC (967.21, 1997) for fruits and vegetables. The results were expressed as mg AA / 100 g sample.

The extraction for the quantification of total phenol content (TPh) was carried out using the technique described by Peiró et al. (2006) and were quantified using the Folin–Ciocalteu test (Li et al., 2006). Results were expressed as the equivalent of milligrams of gallic acid (mg GAE·100 g-1 of fresh grape). The same extract obtained for TPh quantification was used for the determination of antioxidant capacity (AC). The antioxidant capacity was determined by a modification of the spectrophotometric technique developed by Re et al. (1999), using the ABTS+ radical (Sigma) generated by 2.45 mM potassium persulfate ($K_2S_2O_8$). The mixture was allowed to stand in the dark at room temperature for 16 h before use, and then the ABTS•+ solution was diluted to give an absorbance of 0.7 ± 0.1 at 734 nm. Following 100 µL of tomato extract were mixed with 900 µL of the ABTS•+ diluted solution, and the absorbance was measured at 734nm. The results were expressed as µmol equivalents of Trolox (TEAC)·100 g-1 of fresh sample. All the experiments were replicated thrice.

Lycopene extraction was based on the method of Fish et al. (2002). Lycopene was estimated by the following formula (Fish et al. 2002).

$$Lycopene\ (mg/100g) = \frac{\mathrm{A}^{503}\ \mathrm{x}\ 31.2}{\mathrm{g\ of\ sample}}$$

where $A^{503}$ is the samples absorbance at 503 nm and 31.2 is the extinction coefficient.

All values expressed are means of triplicate determinations ± standard deviation. The data were subjected to one-way analysis of variance (ANOVA) with a significant level of 5%. Pearson's correlation test was conducted to determine the linear correlations between determinations using Statgraphics Centurion software (16.1.15 version, USA).

## RESULTS AND DISCUSSION

Table 1 shows the values obtained from analysis of moisture, ° Brix, pH, total acidity and maturity index. According to the results, the ETS tomato presented significantly lower values of moisture (α=0.05) compared to the others. Statistically significant

differences (α = 0.05) in the ° Brix, pH and total acidity were observed. Tomatoes EST showed higher values in the ° Brix and titratable acidity. Brix values were similar to those described by other authors (Charanjit et al. 2013). Soluble and total solids are important traits for processing tomatoes and contribute to the definition of the concentrated tomato product. Soluble solids represent sugars and organic acids, whose ratio, together with the composition in volatile aroma, characterizes the flavor of the fruit (Véronique Bergougnougx, 2014).

**Table I**. Mean values of moisture content, ° Brix, pH, total acidity and maturity index in the EST, CST, and commercial tomatoes.

| Análisis | EST Tomato | CST Tomato | Commercial Tomato |
|---|---|---|---|
| Water content | 92.8 ± 0.55 [a] | 94.9 ± 0.27 [b] | 94.4 ± 0.82 [b] |
| °Brix | 6 ± 0.2 [c] | 5.3 ± 0.11 [b] | 5 ± 0.2 [a] |
| pH | 5.17 ± 0.01 [b] | 5.02 ± 0.02 [a] | 5.18 ± 0.01 [b] |
| Titratable acidity (mg of citric acid/100g) | 702 ± 16.5 [c] | 528 ± 8.4 [b] | 381 ± 11.0 [a] |
| Maturity Index (°Brix/Titrable acidity) | 8.5 ± 0.2 [a] | 9.51 ± 0.18 [b] | 13.12 ± 0.37 [c] |

Data are means ± standard deviation (n=3). Different lower case letters indicate significant differences between tomotaoes ($p<0.05$).

Figure 1 shows the values obtained in ascorbic acid, phenolic compounds and lycopene. Regarding the content of ascorbic acid, EST tomato (21.2 mg/100g ± 0.85) showed levels significantly (α=0.05) higher than the others, 11.5 mg of ascorbic acid ± 0.8 for commercial tomato and 11.95 mg of ascorbic acid ± 0.01 for CST tomato. Di Matteo et al. (2010) demonstrated that the accumulation of ascorbic acid is achieved by increasing pectin degradation and may be triggered by ethylene.

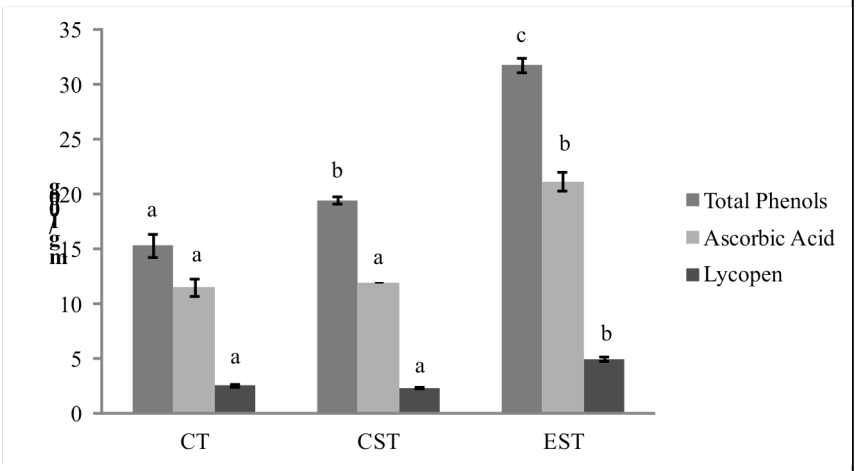


**Figure 1**. Mean values of total phenols (mg Gallic acid equivalent (GAE) / 100g FW), ascorbic acid (mg / 100 g FW) and lycopene (mg lycopene / 100 g FW), for the three types of tomato analyzed. Data are means ± standard deviation (n = 3). Different lower case letters indicate significant differences between tomatoes ($p < 0.05$).

EST tomato also was significantly (α=0.05) higher in the lycopene content (3.84 mg/100g ± 0.17) than the others tomatoes types (Figure 1) 2.5 mg of lycopene/100g for conventional and 2.3 mg of lycopene/100g for semiorganic. Juroszek et al. (2009) mentions that tomatoes modify lycopene production by the genetic characteristics of the seed used as well as the location and seasonality of harvest, and soil characteristics. Thus, the differences found between the amount of lycopene in EST and commercial tomato could be one of these factors, which in our case might be inclined to the cultivation process and the type of seed that was used. The impact of these factors may explain the variability found in the compounds studied.

For total phenolic compounds (Figure 1), statistically significant differences (α=0.05) between all types of tomatoes were observed. These differences may be related to pests stimulate the production of antioxidant compounds, especially phenols (Lumpkin, 2005). EST Tomato showed the highest content (31.8 mg of Gallic acid/100g). Polyphenol quantity and quality in plant foods can vary significantly according to different intrinsic and extrinsic factors such as plant genetics and cultivar, soil composition and growing conditions, maturity state and post harvest conditions, among others (Jaffery et al., 2003).

Figure 2 shows the values obtained from the analysis of the antioxidant activity, 640.2 μM of TEAC/100g for EST tomato, 639.4 and 633.3 μM of TEAC/100g for CT and CST tomatoes respectively. According to the variance analysis, no statistically significant difference (α = 0.05) between tomato tested were observed.

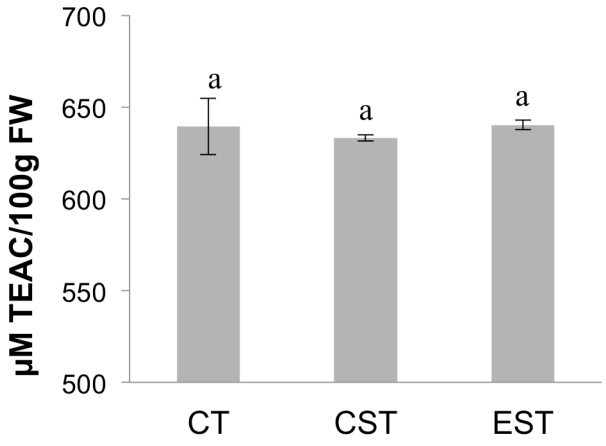


**Figure 2**. Mean values of antioxidant activity (uM Trolox equivalent antioxidant capacity (TEAC) / 100g FW) for the three types of tomato analyzed. Data are means ± standard deviation (n = 3). Different lower case letters indicate significant differences between tomatoes ($p < 0.05$)

Pearson analysis showed that there was positive correlation of phenolic compounds with titratable acidity (P-Value=0.0147, r= 0,9465), with the ascorbic acid (P-Value=0.0054, r= 0.9728), as well as lycopene (P-Value=0.0237, r= 0.9265).

The antioxidant capacity in commercial tomato fruits is strongly affected by many cultural and abiotic factors (Anissa and Chafik, 2013), by genotype (Riadh et al., 2011;) agronomic techniques (Dumas et al., 2003) and light and temperature (Pék et al., 2011). There is also to take into account the synergistic effects and redox interactions among the different nutrient and "non nutrient" molecules which together contribute to the supposed health benefits (Anissa and Chafik,2013).

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