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The wild tomato (*Solanum lycopersicum* var. *cerasiforme*) of western Mexico, an alternative food, nutritional, and socio-economic

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Abstract

Mexico has wide genetic variability of tomato (*Solanum lycopersicum* L.), resulted from a long processes of domestication and diversification. Currently is one of the most important crops relating to marketing and use. However it is considered to *Solanum lycopersicum* var. *cerasiforme* wild ancestor of cultivated tomato, there is little information of this species, although it has recently highlighted its productive and ecological importance. Currently different investigations are aimed at assessing the benefit in their consumption due to its chemical composition, which provides a number of nutritional components such as carotenoids, vitamins A and C, sugars, minerals and antioxidants. This research was conducted to meet its quality physical, chemical, food, and nutritional. Collected seeds from wild plants of Jalisco, Colima, Michoacán and Nayarit; were planting in greenhouse at the University of Guadalajara; fruits produced were subjected to physical and chemical analysis in the laboratory. According to statistical analysis, there were significant differences in size and chemical composition, between populations and between different production cycles. The results in this study allow a better selection of these populations to be preserved in germplasm Bank at UDG, also contributes to promote its cultivation and human consumption.

Antioxidants, Citric acid, degrees Brix, tritatable acidity

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Introduction

Tomato, originally from the Andean region shared by Ecuador, Peru, Bolivia, and Chile (Rick, 1976), seems to have been domesticated by pre-Columbian peoples in Mexico and / or Peru where their two natural diversity centers Et al., 1990). The most probable ancestor of the cultivated tomato is the wild tomato Lycopersicon esculentum var. Cerasiforme (Esquinas-Alcázar and Nuez, 1995). In the Mexican biocultural ethnohistory there is evidence of a clear differentiation between green tomato and tomato, called in Nahuatl as miltomatl and xitomatl. To the tomato S. lycopersicum var. Cerasiforme is known in Jalisco, Nayarit and Colima as deer eye, jaltomate, Chaltomate or Tomatillo and in Michoacán as Tinguaraque (Rodríguez et al., 2009).

Tomato is a crop distributed around the world and occupies the second place worldwide, due to the nutritional value that it possesses, since it can be consumed cooked or raw; As well as having generated an entire industry that has activated the economy of many countries. In our country it is primarily a product for export, job creation and is one of the crops with the greatest use of technology and inputs. In the agro-industrial context, the last decade has been an expansionary period for the export sector of fresh tomatoes, market rules and production techniques are constantly evolving and therefore it is important to adapt to these conditions.

An example of this is the European markets which evolve towards a higher quality, forcing a constant improvement in order to successfully compete in the different markets that are increasingly selective and demand better quality attributes. The quality criteria considered by:

A) Buyer: Aroma, Texture, Taste, Size and Color

B) For Commercialization and Exportation it is required: Tomatoes: Healthy, Fresh, Clean, Dry, Mature, Firm and Well-formed

C) Consumer chooses: Color, Shape, Size, Consistency, Maturity and Presentation

Despite the importance of this fruit, we do not have much information about its properties growing in the wild, so we present data on the variation in size and chemical composition of tomato in wild populations of Solanum lycopersicum Var. Cerasiforme, that are developed in the West of Mexico, emphasizing its nutritional, alimentary, medicinal, socioeconomic and ecological importance.

Objetive: To determine whether wild tomato represents a nutritional, nutritional, and socioeconomic alternative for the inhabitants and wild fauna that live in areas where wild populations of tomatoes develop Solanum lycopersicum var. Cerasiform.

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Materials and Methods

Fruit pick.- Wild plants and native tomato varieties were collected during the years 2002 to 2006 and 2010 to 2012, in different regions of the West, using random sampling. Ten plants were randomly selected by locality and ten mature fruits of each one were taken, to which the seed was extracted, by means of liquefaction.

The seeds decanted at the bottom of the blender vessel were placed in weathering paper for drying for 24-48 h, seeds having good conditions were placed in a previously identified glass vial and stored in a refrigerator at a temperature of about 10 ° C.

Cultivation of the tomato.- Later the seeds were planted in the greenhouses located in the University Center of Biological and Agricultural Sciences of the University of Guadalajara during the cycles of spring-summer agricultural cultivation. The sample size was 30 plants.

Analysis.- The fruits collected from the greenhouse were taken to the laboratory where they were carried out a physical analysis and a chemical analysis.

Physical analysis of the fruit.- The weight (g) was determined with a scale with decimos of grams. Subsequently, the polar and equatorial diameter (mm) of each fruit was measured using a vernier.

Chemical analysis.- The fruits were split in half and separated from the peel, gently rubbing it in a colander collecting the pulp in a container, and the seeds were washed and dried at room temperature.

The pulp was determined: Total soluble solids (Brix degrees), citric acid (AT) and pH.

The seed was determined: Ash; Crude Protein; Crude Fat; Crude Fiber; Humid Matter; Dry material; Lignin; Calcium and Phosphorus.

Statistical analyzes were carried out using the statistical package SPSS® version 19 and SAS version 8.1. The data were evaluated for normality using the Kolmogorov - Smirnov test and for homogeneity of variances using the Levene Dytham test. The parameters of fresh weight, equatorial and polar diameter as well as ° Brix, pH and citric acid were compared between populations per year using a one-way ANOVA. Data from all harvests were analyzed using a two-way ANOVA (or combined with population and age factors), (Kinnear et al., 2000). In the variables where significant differences were found, Tukey's means comparison tests were performed at 5%.

Results

Populations from the West of Mexico show an interesting variability in the physical and chemical quality of the fruit.

According to the physical analysis, the weight oscilo of 1.34 - 2.62 grs. The fruits that presented the greatest fresh weight, (larger) belong to the populations from Sayula, Jalisco and Tierra Generosa, Nayarit. As for the equatorial diameter are between 12.88-15.68 mm and the polar 12.86 - 15.93 mm, where the fruits of Tecalitlán Jalisco, Tierra Generosa Nayarit, Yurécuaro Michoacán and Tequila Jalisco were the populations that showed the highest values.

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In the chemical analysis in the pulp Although soluble compounds and titratable acidity (AT) include a group of compounds (glucose, fructose and to some degree sucrose) and organic acids (citric or malic), flavor of the tomato depends on the balance between the sugar content (° Brix) and citric acid. The results obtained from the studied populations provide the following: Total Soluble Solids (° Brix) most of the values obtained in this research are between 5.5 - 10.6 ° Brix. The sweetest fruits being those of Tequila Jal., San Miguel del Zapote Jal., Tecalitlán Jal., And La Rosa Tamazula de Gordiano Jal. Commercial parameters require minimum 6 ° Brix. The ranges obtained in citric acid (titratable acidity or AT) were 0.42% - 0.83% Alcaraces Colima and Nayarit Coamiles are the ones with the highest percentage. As for the pH, in general all the fruits present between 4.35 - 5.25; being observed that there is not a significant difference between the different localities, corresponding in general terms to an acidic pH.

Chemical analyzes of the seeds contributed values between the following ranges: Crude protein content between 19.08 - 32.25% the highest is the tomato of Las Palmas Chápala, Jalisco. Crude fiber of 27.36- 44.26% higher than Coahiles Nayarit. Crude Fat 11.52 - 65.06% higher than Yurécuaro Michoacán; Calcium 0.48 - 2.19% the highest Nayarit Coamiles. Phosphorus 0.18- 1.15% higher Generous Earth Nayarit. Ash 3.05 - 6.81% higher in Las Palmas Chápala, Jalisco. Lignin 21.54 - 64.34% higher the fruits of San Miguel del Zapote Jal. Dry matter 72.22 - 95.63% higher Sayula Jalisco and Humeda matter 4.35 - 7.68% higher those of Tecalitlán Jalisco.

According to the statistical analysis there are significant differences in fruit size y Chemical composition of the pulp between populations and between different cycles.

The presence of a significant interaction involves variable responses of the genotypes over time. The variability present in the populations was maintained through the evaluation cycles being the result of an interaction with the environment, of the climatic type of the locality of origin, which leads to the proposal of the existence of ecotypes

Sources of variation	Grades of freedom	Fresh weight (g)		Ecuatorial diameter (mm)		Polar Diameter (mm)		Soluble Solids (°B)		pH		Titratabl (%
		CM	Prob.>F	CM	Prob.>F	CM	Prob.>F	CM	Prob.>F	CM	Prob.>F	CM Prob.
Towns	11	0.666	***	15.8	***	13.9	***	32.2	***	0.19	***	0.12 **
Years	2	5.15	***	109	***	94	***	26.5	***	12.9	***	0.04 **
Interaction	22	1294	***	7.02	***	7.06	***	7.14	***	0.19	***	0.07 **
Error	198	0.98		1.04		0.926		1.2		0.03		0.01
Total	359											

** Significativo (Prob≥0.01), *** Significativo (Prob. ≥0.001)

Table 1 Analysis of variance of physical and chemical characteristics of tomato (Solanum lycopersicum var. Cerasiforme).

Discussion

From the results obtained in this study we can say that the tomato Solanum lycopersicum var. Cerasiforme, easily competes with the cultivated tomatoes as observed in the comparative analysis with the results of the analysis of other works and other types of tomato (Tables 2 and 3)

Parameter	Juárez-López *et al.* 2009 (Guerrero y Puebla)	Juárez-Crisanto *et al.* 2010 (Oaxaca)	Resultados de nuestro estudio (Occidente de México)
°Brix	5.8 – 8.0	4.5 – 9.3	5.20 – 10.8
pH	4.1- 4.4	3.63 - 4.3	4.28 – 5.03
% AT	0.50 - 1.01	0.32-1.45	0.40 - 0.83

Table 2 Comparative analysis with other studies on tomato cultivated in Mexico

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In these tables it is observed that the tomatoes of our study, the ° Brix values are higher which means a better taste (more sweet), increasing the desirable sensorial characteristics that influence the consumer acceptance.

Parameter	Red Cherry tomatoe	Yellow Cherry tomatoe	Ball tomatoe	Study results (Occidente México)
°Brix	6.5	3.9	3.6	5.20-10.8
pH	4.3	4.3	4.3	4.28–5.03
% AT	0.42	0.35	0.34	0.40- 0.83

Table 3 Comparative analysis with studies conducted by Kowalczkety (et al., 2011)

In the last years the different researches oriented to evaluate the benefit in tomato consumption due to its chemical composition has increased the interest to study its medicinal, nutritional and functional value, for the benefits of its consumption, both in the state Fresh as in products derived (juices, sauces, puree, soups, stews among many). There are several reports of epidemiological studies describing the potential of tomato in human health. For this reason we will show the most relevant nutritional and socioeconomic medicinal aspects derived from all these studies in this fruit, to which is added ours.

Nutritional alternative.- The wild tomato Solanum lycopersicum var. Cerasiforme has specific physical-chemical and sensory characteristics that distinguish it from other variants of tomato. Its chemical composition is composed of: carotenoids (lycopene, phytofluene, lutein, phytoene, gamma-carotene, neurosporene, beta-cryptoxanthin, all-trans-beta carotene, cis- beta-carotene, beta-carotene, alpha-carotene and zeaxanthin), Vitamins (A and C), which act as antioxidants, as well as minerals (macroelements: Mg, S, Ca, P and K, microelements: Cu, Fe, Zn and Mg, other Na and Se elements), organic acids (Citric acid), and phenolic compounds (gallic acid, chlorogenic acid, caffeic acid, mirecetin and naringenin) and sugars. (Chavez et al., 2011).

The content of vitamin C (or Ascorbic Acid), is between 8.6 - 82 mg / 100mg in fresh fruit (Guil and Rebolloso, 2009, Crisanto et al., 2010, Méndez et al., 2011). This vitamin is essential for collagen biosynthesis (Li and Schellhorn, 2007). It participates in the activation of enzymes, reducing oxidative stress, in the immune system, protects the respiratory tract from infections, reduces risks to cardiovascular diseases and cancer (Schlueter And Johnston, 2011, Li and Schellhorn, 2007). It is estimated that by consuming 100 g of this fruit, it can cover 90% of the daily requirement of lycopene, which is 75 mg in women and 90 mg in men, minimum to exert its antioxidant action in the organism (Hernández, 2004). It was identified that the minerals are in a higher content in wild tomatoes (Guil and Rebolloso, 2009, Fernández et al., 2011). It is considered that consuming 100 grams of this tomato daily, provides the requirement of 35.2% copper (Cu); 11.2% iron (Fe); 6.4 potassium (K); 5.73% zinc (Zn); 1.76% selenium (Se); 1.2% calcium (Ca); And 0.1% manganese (Mn) (Hernández, 2004, FAO, 2016).

Food alternative. During the harvest season of wild tomatoes, it means an alternative food for the communities that inhabit these areas, and for the places where they market them, replacing it with other types of tomato. For the wildlife that lives in the areas where these tomato populations develop, it is an alternative food for birds, rodents, insects and bats, representing in some cases the only source of food that will provide them with water (as this Fruit has a high content of it), the nutrients mentioned above that are in this fruit.

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This type of studies, because of the nutritional information it provides regarding knowledge of the chemical composition of fruits (proteins, lipids, carbohydrates, vitamins and minerals) of tomato and its components (pulp and seeds), allows to know the nutritional contribution they have These fruits for the consumer, because this fruit has the advantage that their seeds are so small that when chewing or grinding the whole fruit releases its chemical components, taking advantage of the nutrients of the husk, pulp and seeds. The zoologist provides information on the nutrients consumed by the local wildlife, and the nutritionist to have the knowledge of the nutritional contribution of these fruits that will allow you to introduce it into the daily diet as an alternative to other foods during the months when it occurs. It was also identified that one of the most important ecological aspects of the wild populations of tomato Solanum lycopersicum var. Cerasiforme is due to its herbaceous, creeping or climbing plant, the stems extend up to 7 m long in tropical or subtropical places when it has no moisture restrictions and in semi-arid or low rainfall does not exceed 50 cm or 1 (Lobato et al., 2011), thus providing food for some species of wild animals such as insects, bats, rodents and birds, constituting as one of the key plants of the ecosystem in which they develop.

Medical alternative.-Potassium is involved in the regulation of blood pressure, reduces the adverse effect of excess sodium in the blood and reduces the risk of kidney stones. Calcium and phosphorus are bone and tooth builders, with the possibility of reducing osteoporosis by age (Chavez et al., 2011). Iron is part of hemoglobin, preventing anemia. Selenium is part of the glutathione peroxidase enzyme of human erythrocytes. Manganese participates as an enzymatic cofactor of the metabolism of amino acids, lipids and carbohydrates.

Zinc acts as a catalyst for several enzymes conferring the maintenance and structural integrity of proteins and participates in the regulation of gene expression (Hernández, 2004). Carotenoids are antioxidants that have the ability to react with reactive oxygen species that are produced under conditions of photooxidative stress, and together they have a protective effect against prostate cancer and oxidative DNA damage (Porrini and Riso , 2000; Khachik et al., 2002). Lycopene has the ability to modulate the metabolism of androgens, hormones that are associated with prostate cancer and decreased estrogenic activity (Erdman et al, 2009).

Socioeconomic Alternative.- Globally, tomato (Solanum lycopersicum is the second most cultivated vegetable after potato, with 3,744,563 have been planted.Mexico ranks 10th in the world in area planted annually with about 70,000 ha, in our country Is one of the most important vegetables because of the large number of direct and indirect jobs generated by its cultivation, the number of foreign currency entering the country through its commercialization (Lobato et al., 2012).

It also represents an economic alternative, in the main regions of the West of our country where populations of wild tomato Solanum lycopersicum var. Which are consumed or marketed in local markets or nearby cities, thus becoming a food and socioeconomic complement of the communities settled in these areas, which confirms the economic importance of these Populations.

Conclusions

Populations from the West of Mexico show an interesting variability in the physical quality of the fruit; As well as in the biochemical and nutritional quality.

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According to the analysis obtained in our study, both pulp and seeds (because when chewed or crushed) together, they confer a significant contribution of: minerals, proteins, carbohydrates (being a source of glucose and fructose), water Has a high content of it), lipids (providing essential fatty acids), and are a good contribution of vitamins, organic acids, carotenoids, antioxidants, and phenolic compounds, for people and wildlife that consume them.

Wild tomatoes are a good alternative food for the consumer that can substitute for other types of tomato, and for wild animals may represent their only source of food at the time they appear.

The constant consumption of this type of tomato provides the necessary nutrients that can prevent certain pathologies and diseases representing a good medicinal alternative for the consumer.

The production and harvesting of tomato from wild populations represents an important socioeconomic activity for the rural communities settled in the West of Mexico, where it is observed that they commercialize it in the squares, tianguis and some markets. It should be noted that this production is obtained at very low cost (without any anthropogenic energies), which represents for the collectors extra income with little investment. Based on the results obtained, it can be concluded that Solanum lycopersicum, a cerasiform variety, may represent an alternative for the inhabitants and wild fauna that inhabit these areas of the West of Mexico: medicinal, nutritional, nutritional and Socioeconomic

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