**Evaluation of antioxidant content in introductions of cherry tomato (Solanum spp.)**

**Evaluación del contenido de antioxidantes en introducciones de tomate tipo cereza (Solanum spp.)**

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Abstract

The greatest genetic diversity of tomato (*Solanum lycopersicum* L.) is found in wild species, with variability in fruit quality characteristics such as flavor, aroma, color, and content of lycopene and β-carotene. The aim of this study was to determine the content of antioxidants (lycopene, β-carotene and vitamin C) in cherry tomato fruits of 30 wild introductions from the Germplasm Bank of the National University of Colombia in Palmira. The field study was conducted at Montelindo farm, property of the University of Caldas, with an average temperature of 22.8 °C, at 1010 masl, 2200 mm of annual precipitation and relative humidity of 76%. The experimental design used was a rectangular lattice, with 30 treatments (introductions) and a commercial control (Sweet million) in four replicates per treatment and five plants in each one as experimental unit. The evaluated variables were lycopene, β-carotene, vitamin C and acidity of the fruit, which were determined by spectrophotometry and titration by color change and pH. Additionally, fruit production of the introductions was assessed. Data were analyzed using ANOVA and Duncan mean test by using SAS software (SAS Institute, Cary NC). Finally, we applied a weighted selection index based on the variables lycopene, β-carotene and vitamin C, applying a selection pressure of 17%. Significant differences (P <0.05) for the evaluated variables were found. The highest content of lycopene was found in the introduction LA1455 with 0.32 µg/ml, that of β-carotene in the introduction LA2076 (0.095 µg/ml), and vitamin C in commercial control (Sweet Million) (85 mg/100 g). The selection index showed as promising introductions: IAC 445, LA2076, LA2710, LA2845, and LA1546, indicating that phenotypic diversity exists among the introductions assessed for variables lycopene, β-carotene and vitamin C.

**Key words:** β-carotene, lycopene, plant genetic resources, vitamin C.

Resumen

La mayor diversidad genética de tomate (*Solanum lycopersicum* L.) se encuentra en especies silvestres, con variabilidad en características de calidad del fruto como sabor, aroma, coloración, y contenidos de licopeno y b-caroteno. El objetivo del presente trabajo fue determinar el contenido de antioxidantes (licopeno, b-caroteno y vitamina C) en frutos de tomate tipo cereza de 30 introducciones silvestres existentes en el Banco de Germoplasma de la Universidad Nacional de Colombia sede Palmira. El estudio de campo se realizó en la granja Montelindo de la Universidad de Caldas; temperatura promedio de 22.8 °C; a 1010 m.s.n.m.; 2200 mm de precipitación pluvial anual y una humedad relativa de 76%. El diseo experimental fue látice rectangular, con 30 tratamientos (introducciones) y un testigo comercial (Sweet million), con cuatro repeticiones por tratamiento y cinco plantas en cada una de ellas como unidad experimental. Las variables evaluadas fueron licopeno, b-caroteno, vitamina C y acidez del fruto, determinadas por espectrofotometría y titulación por cambio de color y pH. Adicionalmente se evaluó la producción de frutos. Los datos fueron analizados utilizando pruebas de varianza y prueba de medias por Duncan, con el programa SAS (SAS Institute Cary N.C). Finalmente se aplicó un índice de selección ponderado con base en las variables licopeno, β-caroteno y vitamina C, con aplicación de una presión de selección de 17%. Se encontraron diferencias significativas (P < 0.05) para las variables evaluadas. El mayor contenido de licopeno se halló en la introducción LA1455 con 0.32 µg/ml, el de b-caroteno en la introducción LA2076 (0.095 µg/ml), y el de vitamina C en el testigo comercial (Sweet million) (85 mg/100 g). El índice de selección mostró como introducciones promisorias: IAC 445, LA2076, LA2710, LA2845, y LA1546, lo cual indica que existe diversidad fenotípica entre las introducciones evaluadas para las variables licopeno, β-caroteno y vitamina C.

**Palabras claves:** β-caroteno, licopeno, recursos fitogenéticos, vitamina C.

Introduction

Tomato (*Solanum lycopersicum* L.) is the most important vegetable of Colombia and the world. It comprises 30% of the world vegetable production with 4.4 millions of cultivated hectares and 145,751,507 t of harvested fruits in 2010. In Colombia, tomato production for the same year was 546,322 t with a cultivated area of 16,227 ha and a yield of 33.66 t/ha (Faostat, 2010).

This species is grown in all the continents and represents one of the main sources of impor­tant vitamins, minerals and fiber (Esquinas-Alcázar and Nuez, 1995), for health and hu­man nutrition (Razdan and Matoo, 2007). It contains different nutrients and molecules like ascorbic acid, vitamin E, flavonoids, phe­nolic acids and carotenoids (Kuti and Konuru, 2005); it is the main source of lycopene for humans and is consumed in fresh or proce­ssed (Candelas-Cadillo *et al*., 2005).

Carotenoids are one of the several families of plant metabolites derived from isoprenoids and share a five carbon precursor, isopentyl pyrophosphate (IPP), with close to 20,000 plant metabolites. Four IPP units are bound to form a subunit with twenty carbons: geranyl geranyl pyrophosphate (GG PP). The first step for carotenoids biosynthesis is the bonding of two GGPP molecules to form phytoene of forty carbons. Four steps are required from the precursor phytoene to get a series of 11 con­jugated double bonds found in lycophene.

The first two desaturations are catalyzed by the phytoene desaturase (PDS) producing phytofluene followed by ζ-carotene (Adalid, 2011). Conversion of ζ-carotene to neuros­porene and later to lycophene is done by the ζ-caroten-desaturase (ZDS), which has a high activity since the ripe tomato fruit has small amounts of ζ-caroten or neurosporene (Fraser and Bramley, 2004). Lycophene is the main carotenoid accumulated in ripe tomato, and it is the starting point in the biosynthetic path­way of other carotenoids, like formation of β-carotene (Adalid, 2011).

Vitamin C biosynthesis starts from two plant compounds, D-galacturonic acid and D-galacturonic acid methyl ester, which produce ascorbic acid by the Wheeler-Smirnoff reac­tion (Wheeler *et al.*, 1998). According to Miller and Tanksley (1990) most of the tomato diver­sity is found in its wild relatives, with genetic diversity for traits such as flavor, aroma, color and texture, with high nutrient content of vitamin C, higher than 57 mg/100g in fresh weight and, high lycopene content, higher than 10 mg/100 g. Recent tendencies on ge­netic breeding for new commercial cultivars are oriented to incorporate quality traits such color, hardness, taste and high carotenoids content. All these are found in higher propor­tion in traditional cultivars than in the co­mmercial ones which have been selected by productivity and agronomical characteristics of interest before that fruit quality (Valcárcel, 2009).

Fruit and vegetable consumption with high antioxidant levels is considered as a way to prevent cardiovascular diseases and cancer, which is associated with higher demands during the last years. Tomato consumption has been stable in time, stimulating its ge­netic breeding to obtain new cultivars high on lycophene, β-carotene and vitamin C contents (Adalid *et al*., 2007). Raffo *et al*. (2003) studied sources of vitamin C, E and specific carote­noids and determine that tomato is the first source of lycophene (71.6%), second in vita­min C (12%) and β–carotene (17.2%) and third as vitamin E source (6%). Nutritionists esti­mate the daily requirement of lycophene is between 3 and 7 mg, meaning a weekly con­sumption of seven portions of tomato rich products (Rodríguez, 1999). Abushita *et al*. (1997) estimate a daily requirement of 60 to 100 mg of vitamin C to reduce the risk of chronic diseases and to be in good health.

According to Abadie and Berretta (2001), the value of the germplasm banks reside on its use. Collections must provide breeders with different genetic, genes or genotypes, which allow them to respond to new challenges established by the productive systems; for that purpose is indispensable to know the charac­teristics of the conserved germoplasm. Cherry tomato adaptation provides high possibilities for inclusion in breeding programs, using their valuable characteristics on genetic diver­sity for selecting parentals, together with their large geographical diversity (Medina and Lobo, 2001). Some cherry tomato species are con­sidered promising for the market due to their high content of antioxidants like lycophene and β-carotene (Nuez, 1999). These characters of wide genetic variability and the genes that they bring, warrant the inclusion of wild spe­cies in breeding programs for cultivated to­mato, in order to evaluate heterozygous com­binations of traits of agronomical interest (Pratta *et al*., 2003).

Nowadays, the internal quality (nutritive and organoleptic) is one of the main goals of tomato breeding for fresh market (Roselló *et al*., 2000). Additionally, is important to identify sources for stress resistances, biotic and abiotic, and for high nutritional quality that contributes to a sustainable agriculture ma­nagement.

There are genetic sources of cherry tomato in Colombia that have not been evaluated for quality traits as lycophene, β-carotene and vi­tamin C, thus its potential use in breeding programs is unknown. This resource use is subjected to previous identification and selec­tion of promising materials. In this study thirty wild introductions of cherry tomato (*Solanum* spp.) from the Germplasm bank of the National University of Colombia-Palmira were evaluated to select genotypes based on their antioxidants (lycophene, β-carotene and vitamin C) content in order to breed commer­cial tomatoes and cherry tomato.

Materials and methods

The experiment was performed in the Mon­telindo farm from the Universidad de Caldas, located in Palestina (Caldas), Colombia, with mean temperature of 22.8 °C, at 1100 masl, with 2200 mm of annual precipitation and relative humidity of 76%, in sandy loam soil derived from volcanic ashes. Thirty introduc­tions of cherry tomato without characteriza­tion reports were used in order to include them in cultivated tomato breeding programs. The commercial control used was Sweet mi­llion (Table 1).

Plantlets were grown in trays of 72 spots with peat as substrate and were transplanted when they had four true leaves; sowing was done in the second semester of 2010. Experimental design used was a rectangular lattice 5 x 6 (30 introductions) with two replicates per main block and the experimental unit was compo­sed of 5 plants per introduction sowed at 1.5 m x 0.8 m. Agronomical practices were the conventional ones for a commercial tomato crop and the plant architecture was defined in three axes/plant. For weed control it was used padding with black-white plastic 0.8 m wide, 1.2 caliber. Fruits were harvested when totally ripe according to the behavior of each intro­duction.

**Variables measured**

**Fruit acidity and vitamin C content.**

For these measurements were taken 10 ml samples of juice from 10 fruits of the second cluster of each introduction and replicate, harvested at ripening stage. Each sample was diluted in 100 ml of distilled water and titra­ted with NaOH 0.1 N till pH 8.2 to express the result as citric acid (%) for fruit acidity. For vitamin C the solution was titrated with iodine 0.1 N till changes in color, expressing the re­sult in milligrams/100 g of fresh weight (mg/100 g) (IPGRI, 1996).

**Lycopene and β–carotene contents.**

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| **Table 1.** Cherry tomato introductions evaluated by antioxidants content. |
| **Introduction (no.)** | **Tomato type** | **Introduction (no.)** | **Tomato type** |
| IAC391a | Red Cherry | LA1546 | Cherry |
| IAC420 | Cereja  | LA1705 | Cherry |
| IAC421 | Cereja Alemão Vermelho | LA2076 | Cherry |
| IAC424 | Cereja | LA1334 | Cherry |
| IAC426 | Cereja Juliet | LA2131 | Cherry |
| IAC445 | Cereja Jundiai | LA168 | Cherry |
| IAC1621 | Cereja alemán 12 | LA2640 | Cherry |
| IAC1624 | Cereja | LA2692 | Cherry |
| IAC1685 | Cereja 11B | LA2710 | Cherry |
| IAC1688 | Lili cereja | LA2845 | Cherry |
| IAC1622 | Cherry | LA3139 | Cherry |
| IAC1686 | Cherry | LA3652 | Cherry |
| IAC412 | Cherry | LA1455 | Cherry |
| IAC416 | Cherry | LA1428 | *S. pimpinelifollium*  |
| LA 1480 | Cherry | LA3158 | *S. pimpinelifollium*  |
| Testigo | Sweet million |  |  |
| a**IAC:** Introductions from the Agronomical Institute of Campinas, Campinas, Brasil.b**LA:** Introductions from the Tomato Genetics Resources Center (TGRC). University of California, Davis. |

For these measurements 0.6 g of tomato pulp were weighted for each introduction and replicate, harvested at ripening time. Next, 5 ml of acetone-n-hexane mix on 4:6 ratio were added. It was centrifuged at 5000 rpm, for 5 min at 4 °C; supernatant was extracted and read on a spectrophotometer of visible light at wavelengths of 453 nm, 505 nm, 645 nm and 663 nm using the acetone-n-hexane mix as blank according to Rosales’ methodology (2008) standardized for tomato fruits. Lyco­phene and β–carotene contents were quanti­fied using the following equations proposed by Nagata and Yamashita (1992) for tomato anti­oxidants.

*Lycophene (µg/ml) = 0.0458 A663 +0.204 A645 + 0.372 A505 - 0.0806 A453*

*β-carotene (µg/ml) = 0.216 A663 - 1.220 A645 - 0.304 A505 + 0.452 A453*

Tomato yield per introduction and replication was expressed in grams per plant (g/plant) and in tons per hectare (t/ha).

Analysis of variance of the data was performed by the GLM procedure of SAS SAS (1992) (SAS Institute Cary N.C; version 9.0) for mean comparison through the Duncan’s mean test. From the best obtained results, a pressure of selection of 17% was applied to select the best introductions, using as criterion the weighted selection index. The selection index (ISi) was built considering the lycopene, β-carotene and vitamin C traits, using the same weight for each one of them (33.33%). For vitamin C the obtained results were expressed as grams per 100 g of fresh weight, thus, all the variables were express in decimals to keep the selection index unaltered. This index is defined as fo­llows:

*ISi* = = [*Pj* (*X ij* - *X*. *j* )/*Sj* ]

where,

*Pj* = correspond to the weighting.

*Xij* = mean of the genotype *i* for thecharacter *j*.

*X.j* = mean of the population for the character *j*.

*Sj* = Standard deviation for the character *j*.

17% of the genotypes were selected with the best ISi values and above 0.

 Results and discussion

Data analysis showed that all the evaluated variables were significantly different (P < 0.05).

**Fruit production.**

For production per plant, introductions with the highest yields were: IAC426 (2040 g/plant, equivalent to 17 t/ha) and IAC1624 (1937 g/plant and 16.1 t/ha); control produ­ced 2055 g/plant and17.1 t/ha, however, this had the largest number of damaged fruits (1570 g and 13 t/ha) (n.p.); LA3158 introduc­tion showed the lowest yield (277 g/ plant and 2.3 t/ha) (Table 2). Zaror (1996) found with cherry tomato under greenhouse that the largest yield was in the Sweet cherry (2739 g/plant) cultivar, value that is similar to the ones found in this study for IAC426 and IAC1624 and with the control (commercial cherry tomato F1 Sweet million) (2055 g/plant). Macua *et al*. (2006, 2008) observed in nine varieties of cherry tomato and average yield of 85.78 t/ha and 2 years later, working with eleven cherry tomato varieties they found yield between 66 and 103.68 t/ha. Uresti *et al*. (2007) in tomato grown hydroponically found yields of 30.1 t/ha in a population of 25,650 plants/ha.

In this study, the highest ripe tomato pro­duc­tions were obtained with the control Sweet million (17.1 t/ha) and with the introductions IAC426 (17 t/ha) and IAC1624 (16.1 t/ha) on a density of 8333 plants/ha (Table 2).

**Lycopene and -carotene contents.**

LA1455 and LA2845 introductions had the highest lycopene contents with similar con­centrations of 0.32 µg/ml, followed by the IAC426 introduction with 0.30 µg/ml; howe­ver β–carotene content in both of them can be considered low. The lowest lycopene contents were found in IAC412 (0.04 µg/ml) and LA2640 (0.02 µg/ml).

LA2076 introduction had the highest -carotene content (0.096 µg/ml) followed by IAC412 with 0.094 µg/ml. In total 11 intro­ductions representing 35% of the population did not show -carotene content and had acceptable contents of lycopene (Table 2). It is estimated that between 87% and 90% of the carotenoids in tomato are carotenes (Fraser and Bramley, 2004). Lycopene is the most abundant carote­noid in red tomatoes and can represent 90% of the total carotenoids in this vegetable (Ada­lid, 2011), results that agree with the ones found in this study where the lycopene per­centage was 86.1% for the total carotenoids. According to Adalid (2011) a typi­cal red to­mato fruit has lower levels of other pigments like -carotene, -carotene, -caro­tene and neurosporene. In this study, 14 in­troductions with 80% of red fruits showed higher lycopene contents than the average (0.18 µg/ml) (n.p.), whereas the introduction with ripe fruits with colors between red and pink had higher β–carotene contents. Lyco­pene concentration in tomato fruits depends on the genetic compo­sition and the interaction between genotype and environment. High light intensities favors carotenoids content, in spe­cial the one of ly­copene (Dumas *et al*., 2002), which agrees with the light conditions in the location of the study and the genetic variabi­lity of the eva­luated germplasm, favoring higher lycopene contents instead of β–caro­tene in some intro­ductions.

Zambrano *et al*. (1995) evaluated lycopene content in two tomato cultivars (Rio Grande and pear type varieties) and concluded that lycopene synthesis increases progressively during the ripening of the fruits; in Rio Grande from 0.233 µg/g in physiological ma­turity to 28.720 µg/g in ripe stage and, in the pear type from 0.21 µg/g to 29.720 µg/g in the previously named stages. In this research, fruits were harvested at full ripening and reached the maximum values of 0.318 µg/ml in LA1455 and minimum of 0.024 µg/ml for LA2640.

Rodríguez-Amaya (1997) observed an in­crease in carotenoids content, especially lyco­pene, during ripening of tomato fruit. Seven days after the full ripening stage, lycopene levels were 44 µg/g, while for -carotene was 3.0 µg/g. After 21 days, lycopene reached 65 µg/g while -carotene slightly decreased to 2.2 µg/g, indicating that at higher lycopene con­tent -carotene decreases, results that are similar to the ones found in this study.

Lenucci *et al*. (2006) found variations among tomato cultivars, -carotene content changed between 0.5 and 20 mg/kg and lyco­pene bet­ween 8 and 250 mg/kg, and in to­mato intro­ductions var. cesariforme lycopene was bet­ween 0.2 and 17.4 mg/100 g; whereas the highest value was found in *S. pimpinelli­folium* with values of 18 and 25 mg/100 g in dark red fruits. Lycopene content average for the evaluated introductions was 0.18 µg/ml, it was found that 55% of them, including the control Sweet million, had higher values than the average. Hernández *et al*. (2007) found lycopene values between 1.89 and 2.56 mg/100 g in the commercial cultivars Dunkan and Thomas.

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| **Table 2.** Mean test (Duncan) on the evaluation of antioxidant content in 30 cherry tomato introductions.  |
| **Introduction** | **Yield (g/plant)** | **LYC (μg/ml)** | β-**carotene****(μg/ml)** | **Vitamin C (mg/100 g)** | **Acidity****(%)** | **Yield****(t/ha)** |
| Control | 2054 a\* | 0.181 efgh | 0.032 c | 85 a | 1.392 fgh | 17.1 |
| IAC426 | 2039 a | 0.301 ab | 0 e | 33 lm | 1.208 hij | 17.0 |
| IAC1624 | 1937 a | 0.269 bc | 0 e | 60 cd | 1.569 ef | 16.1 |
| LA1480 | 1704 b | 0.259 cd | 0 e | 44 fghijkl | 1.144 ij | 14.2 |
| IAC391 | 1643 bc | 0.173 ghij | 0 e | 38 jklm | 1.352 fghi | 13.7 |
| IAC1688 | 1642 bc | 0.135 jkl | 0.042 c | 51 cdefghi | 1.904 cd | 13.7 |
| LA3652 | 1574 bcd | 0.229 cde | 0.023 cde | 48 efghij | 2.208 b | 13.1 |
| IAC1621 | 1432 cd | 0.244 cde | 0 e | 41 hijkl | 1.568 ef | 11.9 |
| IAC424 | 1421 cd | 0.052 def | 0 e | 52 cdefghi | 1.28 ghi | 11.8 |
| LA2692 | 1420 cd | 0.119 lm | 0.067 b | 33 lm | 1.944 cd | 11.8 |
| LA2131 | 1369 d | 0.238 cde | 0 e | 41 hijkl | 1.456 fg | 11.4 |
| IAC421 | 1348 d | 0.152 ijkl | 0.036 c | 44 fghijkl | 1.544 f | 11.2 |
| LA2076 | 1314 d | 0.086 mn | 0.096 a | 59 cde | 2.072 bc | 11.0 |
| LA2845 | 1032 e | 0.316 a | 0.009 de | 56 cdef | 1.552 f | 8.6 |
| LA1705 | 1013 e | 0.077 no | 0.005 e | 49 defghij | 1.2 hij | 8.4 |
| LA1428 | 979 ef | 0.209 efg | 0.03 cd | 35 klm | 2.048 bcd | 8.2 |
| IAC445 | 958 ef | 0.163 hijk | 0.084 ab | 61 c | 1.04 j | 8.0 |
| IAC420 | 887 efg | 0.123 klm | 0.087 ab | 47 fghijk | 1.872 cd | 7.4 |
| IAC1686 | 878 efgh | 0.123 klm | 0.033 c | 41 hijkl | 2.2 b | 7.3 |
| LA2640 | 817 efgh | 0.024 p | 0.002 e | 35 klm | 1.472 fg | 6.8 |
| LA168 | 814 efgh | 0.228 cde | 0 e | 47 efghijk | 1.472 fg | 6.8 |
| IAC412 | 739 fghi | 0.038 op | 0.094 a | 43 ghijkl | 2.44 a | 6.2 |
| IAC1685 | 629 ghij | 0.179 efgh | 0.007 e | 34 lm | 1.832 cd | 5.2 |
| LA2710 | 619 hij | 0.204 efgh | 0 e | 73 b | 2.008 bcd | 5.2 |
| LA3139 | 551 ij | 0.146 ijkl | 0.004 e | 53 cdefgh | 1.84 cd | 4.6 |
| IAC1622 | 517 ijk | 0.178 efgh | 0 e | 54 cdefg | 1.92 cd | 4.3 |
| LA1546 | 512 ijk | 0.245 cde | 0.038 c | 55 cdefg | 1.792 de | 4.3 |
| LA1455 | 475 ijk | 0.318 a | 0 e | 52 cdefghi | 1.888 cd | 4.0 |
| LA1334 | 418 jk | 0.239 cde | 0.032 c | 40 ijklm | 1.912 cd | 3.5 |
| IAC416 | 388 jk | 0.055 nop | 0.025 cde | 29 m | 1.552 f | 3.2 |
| LA3158 | 277 k | 0.086 mn | 0.033 c | 45 fghijkl | 1.896 cd | 2.3 |

In this study, LA2710 and IAC445 intro­ductions showed fruit vitamin C contents of 73 mg/100 g and 61 mg/100 g, respectively, while the control had a concentration of 85 mg/100 g; in contrast, IAC426 and IAC416 had lower concentrations, 33 mg/100 g and 29 mg/100g, respectively (Table 2).

The introduction with the highest acidity in fruit was IAC412 with 2.44% followed by the LA3652 and IAC1686 introductions with 2.2%; while LA1480 (1.14%) and IAC445 (1.04%) showed the lowest acidity (Table 2). Raffo *et al*. (2003) found that ascorbic acid is highly variable in cherry tomato grown under greenhouse conditions, nonetheless the con­centration is in the range of the recommended daily value for vitamin C (60 mg). LA2710, IAC445, IAC1624 and LA2076 together with the control showed equal or higher concen­trations than this value, thus they are consi­dered like promising as commercial cultivars.

All the evaluated introductions in this study revealed higher vitamin C contents than the ones found by Lenucci *et al*. (2006) who evaluated 20 tomato var. cerasiforme and *S. pimpinellifolium* introductions from the COM AV Germplasm Bank (Center for Agrobiodiver­sity Conservation and Breeding of the Poly­technic University of Valencia-Spain) among them: LA2933 (37 mg/100 g), LA2656 (25 mg/100 g) and BGV009560 (21 mg/100 g). Galiana-Balaguer *et al*. (2000) found that the vitamin C levels in tomato vary significantly according to the species, from 80mg/kg in cultivated varieties till 1.113 mg/kg of fresh weight in *S. pimpinellifolium* L. Rosales (2008) studied cherry tomatoes harvested three times along the production cycle and on a similar ripening stage and found 3.57 mg/g and 3.70 mg/g of citric acid. Urrestarazu (2004) found titrable acidity values for cherry tomato bet­ween 520 and 807 mg/ml of citric acid, whereas in common tomato values were bet­ween 370 and 550 mg/ml. Murray *et al*. (2004) evaluated cherry tomato fruits var. cerasiforme cv. Super sweet grown under greenhouse and harvested at different ripe­ning stages and found titrable acidity (citric acid %) of 1.01% in pink tomatoes, 00.96% in red tomatoes and 0.81 in turning stage, va­lues that are lower to the ones found in this study on similar ripening stages, which varied between 1.04 and 2.44% for citric acid.

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| **Table 3.** Selection index of the lycopene, β**-**carotene and vitamin C parameters of the cherry tomato introductions. |
| **Introduction** | **PDN (g/plant)** | **LYC (μg/ml)** | **β-CAR (μg/ml)** | **Vita C (mg/1OOg)** | **IS** |
| IAC445 | 958.7 | 0.163 | 0.084 | 61 | 1.085 |
| LA2076 | 1314.7 | 0.086 | 0.096 | 58.75 | 0.839 |
| LA2710 | 619.3 | 0.204 | 0 | 72.5 | 0.736 |
| LA2845 | 1032.3 | 0.316 | 0.009 | 55.75 | 0.726 |
| LA1546 | 512.2 | 0.245 | 0.038 | 54.75 | 0.721 |
| Testigo | 2054.6 | 0.18 | 0.032 | 0.085 | -0.327 |
| PDN = Production per plant, LYC = Lycopene content, β-car= β-carotene, Vita C = Vitamine C, IS = Selection Index.= Indice de selección. |

The Selection Index established LA2076, LA2710, LA2845 and LA1546 from the Germplasm Bank at Davis, California, and IAC445 from the Germplasm Bank of the Agronomical Institute of Campinas, Brazil, as the best introductions (Table 3).

Conclusions

* Introductions with higher lycopene con­tent (0.32 µg/ml) were LA1455 and LA2845; with the highest β-carotene con­tent were LA2076 (0.096 µg/ml) and IAC412 (0.094 µg/ml). Fourteen introduc­tions showed lycopene values higher than the average (0.18 µg/ml), 80% of them had red ripe fruits, indicating a direct relation between color and lycopene content.
* The Selection Index showed as best in­troductions LA2076, LA2710, LA2845 and LA1546 from the Germplasm bank of Da­vis, California and IAC445 from the Agro­nomical Institute of Campinas, Brazil; they showed higher values than the average for lycopene, β-carotene and vitamin. Addi­tionally, LA2076 and LA2845 reveal yields above 1000 g.
* There is phenotypic diversity among the evaluated introductions for the ly­copene, β-carotene, vitamin C, fruit acidity (citric acid %) and production, being promising in genetic breeding programs of cherry tomato and of commercial tomato culti­vars.

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