Food Science and Technology
ISSN 0101-2061 (Print)
ISSN 1678-457X (Online)
DOI: https://doi.org/10.1590/1678-457X.10417


# Morphological, mechanical and chemical aspects of processing tomatoes produced in Brazilian savanna

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**Abstract**
The aim of this study was to determine the physical and chemical characteristics of ten processing tomatoes cultivars (H9992, H9553, U2006, N901, E8755, BA5445, F170, HMX, AP533 and CVR) produced in the city of Morrinhos, Goiás State, Brazil, in order to assess the fruit quality and contribute with more subsidies for choosing tomato cultivars for processing by industries. H9992, H9553, N901, BA5445 and HMX genotypes have smaller fruits (length, volume and mass) and higher mechanical resistance of the fruit pulp. H9992, HMX and F170 genotypes also have higher resistance of fruit peel, indicating that these materials are less susceptible to losses during mechanical harvesting and transportation to the industry. Regarding the L* and b* parameters, the less yellow and darker H9992, H9553 and U2006 cultivars are the most recommended for the industry, which seeks genotypes with higher concentrations of lycopene and less carotenes. Processing tomatoes cultivar HMX, H9992, H9553 and U2006 have higher soluble solids, and potential to enable greater industrial efficiency. Therefore, cultivars H9992 and HMX standing out positively in most of the evaluated parameters: have smaller fruits (length, volume and mass), higher mechanical resistance of the fruit pulp, greater resistance of the fruit peel, higher soluble solids content. Therefore, new genetic material that presented better characteristics for industrialization is HMX.

**Keywords:** *Solanum lycopersicum*; morfology; mechanical resistance; color; acidity.

**Practical Application:** Quality of tomatoes for the utilization for industrial processing.

## 1 Introduction

In South America, Brazil leads the production of tomatoes for processing, and this agricultural product is considered to be of great economic importance, both for its representativeness in planted area and the amount produced (Instituto Adolfo Lutz, 2008). Brazil is among the ten largest producers of processing tomato, with the highest production in the State of Goiás, and the Cerrado Region is responsible for 99% of production and processing. Furthermore, it is the most industrialized vegetable in the form of several by-products, such as juices, dehydrated fruit, extracts, ketchup and ready-made sauces (Mattietto et al., 2010; Stratakos & Delgado-Pando et al., 2016; Tomas et al., 2017).

Tomatoes are one of the most widely consumed vegetables in the world, and many varieties are cultivated for either fresh consumption or industrial processing. Tomatoes are one of the most important sources of bioactive compounds, mainly lycopene that represent the main antioxidant compounds found in fresh tomatoes and processed tomato products. However, other bioactive compounds, particularly polyphenols, can contribute to the antioxidant effects (Fattore et al., 2016; Jarquín-Enríquez et al., 2013; Sobreira et al., 2010). Tomatoes contain low calorie and fat, and have basically water, sugar, acids (acetic, citric and malic acid), vitamin C (5.35 to 28.00 mg%), and also traces of potassium, phosphorus and iron (Ferreira et al., 2010; Monteiro et al., 2008).

Tomato industry requires a special type of tomato, which must be produced in decumbent culture, without sophisticated cultural practices, aiming low cost for obtaining the raw material (Filgueira, 2008). Thus, during the process of selecting genotypes for mechanized harvesting, as well as in the choice of cultivar by producer and industry (Integration system), has been evaluated as a matter of priority: the concentration in maturation, the productive potential, the size of the branch (which must be median) to facilitate mechanized harvesting, leaf coverage of the fruits, the permanence of the fruits on the plant for longer period with quality, firmness to allow fruit bulk transport and the peduncle retention index. However, other cultivar inherent characteristics intended for processing such as high content of soluble solids (higher industrial yield), intense red internal coloration (high content of lycopene), thick pericarp (higher resistance to impact and perforation), small stem end (easy to detach from the plant in mechanical harvesting), absence of defects (such as green shoulder, blackheart, zippering and split setting) and resistance to diseases that cause damage to culture, among others, should be carefully evaluated during the selection process (Souza et al., 2008).

*Received 23 Mar., 2017*
*Accepted 15 Aug., 2017*
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Finding plants with all the characteristics in optimal levels is very difficult. For this reason, it is necessary to obtain cultivars that possess a set of viable agronomic and technological characteristics. On the other hand, has not yet been published in the scientific literature about the processing tomato hybrids BA5445 and F170, and also there are no reports of physical-chemical characteristics of the hybrid E8755, HMX and CVR, genetic materials also related in this paper. This is due to the lack of information in the literature on the technological characteristics of the cultivars for processing in the industries. Therefore, the aim of this study was to determine the physical and chemical characteristics of ten processing tomatoes cultivars (H9992, H9553, U2006, N901, E8755, BA5445, F170, HMX, AP533 and CVR) produced in the city of Morrinhos, Goiás State, Brazil, in order to assess the fruit quality and contribute with more subsidies for choosing tomato cultivars for processing by industries.

## 2 Material and methods

Field experiment was conducted in the experimental unit of the Instituto Federal Goiano, located in the city of Morrinhos, Goiás (17° 48' 43.84" S, 49° 12' 3.94", 906 m altitude), topical humid climate, the area presents dark red latosol, with sandy clay loam texture. Samples of tomato fruit from cultivars H9992, H9553, U2006, E8755, BA5445, N901, F170, HMX, AP533 and CVR were provided by Empresa Brasileira de Pesquisa Agropecuária – Embrapa Hortaliças, which set up an experiment for study in resistance of cultivars to bacterial diseases. The design was a completely randomized design (DIC). All the cultivars have subjected to the same conditions of solo, weather, harvest, storage and analyses.

The transplanting occurred on June 15, 2011, in an open field. The soil was prepared conventionally with harrowing and leveling, and liming was made between disking operations with 3.5 Mg $ha^{-1}$ of dolomitic limestone. Irrigation used conventional spraying and was initiated shortly after fertilization, maintaining an average watering shift of two days. On planting fertilizing, 150 g of NPK 4-30-10 formulation was used for every linear 5 m, and in coverage, at 30 days after planting, 90 g of formulation 4-30-16 for every linear 5 m. There was one insecticide spraying, and another with fungicide to control whitefly (*Bemisia argentifolii*) and septoriosis (*Septoria lycopersici* Speg.), respectively. Other cultural practices (manual weed control and sprinkler irrigation) were carried out when required, uniformly in all plots, according to the practices used in commercial crops of the region.

Fruits were harvested in September 2011 (5 kg sample per plot, scorning an edge) bordadura), packed in low density polyethylene bags, properly coded, and immediately transported to the Laboratory of Plant Products Processing at the School of Agronomy of Universidade Federal de Goiás – UFG, located in Goiânia – GO, Brazil. Tomatoes were selected according to appearance, absence of defects, decay and ripening stage. Then, fruits were manually washed for removing surface dirt, rinsed in running water, submerged for 20 min in 150 mg $kg^{-1}$ sodium hypochlorite, and left to dry on perforated tray.

### 2.1 Physicochemical properties of fruits

The transverse and longitudinal diameters and the thickness of pericarp after cross sectioning the fruits were determined using a digital caliper (Import, 300 x 0.5 mm, São Paulo, Brazil), and the results expressed in millimeters. Fruit weight was evaluated with semi-analytical scale (Scientech, AS210, Curitiba, Brazil), and results expressed in grams. Fruit volume was estimated from the volume of water displaced by the introduction of each fruit individually in 1 L beaker, filled with 500 mL of water. Density was calculated using the obtained mass and volume data (Lien et al., 2009). Instrumental parameters of internal color of the pulp were determined with a colorimeter (Color Quest II, Hunter Lab Reston, Canada) (Nascimento et al., 2013). The results were expressed in L*, a* and b*values, where L*is luminosity that ranged from black (L* = 0) to white (L* = 100), a * from green (-a*) to red (+a*) and b* from blue (-b*) to yellow (+b*).

The resistance to penetration or hardness of the skin (exocarp and epidermis) and pulp were determined by reading obtained at one point in the equatorial area of the fruit, using a texture analyzer (Stable Micro Systems Ltda., TAXT plus, Surrey United Kingdom), using a 2 mm diameter probe model PS-2, introduced in the pulp at a depth of 10 mm, at pre-test, test, and post-test speeds of 30, 5 and 30 mm $s^{-1}$, respectively. All physical analyses were carried out in 10 fruits per plot (randomly chosen).

Total acidity (TA) was determined using approximately 10 g of fresh pulp homogenized in 100 mL of distilled water, added of three drops of alcoholic solution of phenolphthalein and titrating with 0,1N NaOH until the turning point (pinkish color). The results were expressed as percentage of citric acid. Water-soluble solids (SS) was obtained using about 10 g of homogenized pulp. About 50μL of macerated was transferred to a prism of a portable refractometer (Instrutherm, RT-30 ATC, São Paulo, Brazil). Maturation index was calculated by the ratio SS/TA. The pH was obtained in 10 mL of homogenized pulp, added to 100 mL of distilled water. The solution was taken to a digital potentiometer (Analion, PM 608, São Paulo, Brazil), calibrated with pH 4.0 and 7.0 buffer solutions.

### 2.2 Statistical analysis

All the physicochemical properties were determined in triplicate, according to the methods recommended by the Instituto Adolfo Lutz (2008), each sample composed one parcel. Data were subjected to ANOVA, using Statistica software (Statsoft, Statistica 7.0, Tulsa, USA), and the averages were compared by Tukey test at 5% significance. The correlation between the variables was calculated using Pearson correlation test, with 1 and 5% significance level, based on biostatistics (Callegari-Jaques, 2003).

## 3 Results and discussion

### 3.1 Physicochemical properties of fruits

The smallest fruit length was observed in cultivar H9992 (Table 1). The largest fruit length was observed in cultivar AP533, followed by cultivars F170 and U2006. Fruit length was positively correlated with mass and volume (0.71 $p \leq 0.05$ and 0.69 $p \leq 0.05$ , respectively). Despite the great variation observed in the averages (321%), there was no statistical difference ($P > 0.05$) in relation

**Table 1**. Morphology of cultivars of processing tomato, 2011 crop. Morrinhos, Brazil.

| Cultivar[1] | Lenght[2] | Longitudinal diameter[2] | Transversal diameter[2] | Pericarp thickness[2] | Weight[3] | Volume[4] | Density[5] |
|---|---|---|---|---|---|---|---|
| H9992* | 56.81[d] | 47.36[a] | 45.30[ab] | 6.15[b] | 69.52[c] | 75.67[c] | 0.919[a] |
| H9553* | 59.33[cd] | 191.71[a] | 47.34[ab] | 6.74[ab] | 77.44[bc] | 83.23[bc] | 0.934[a] |
| U2006 | 65.84[bc] | 50.29[a] | 48.52[ab] | 6.39[b] | 90.50[ab] | 94.90[abc] | 0.953[a] |
| N901 | 60.02[cd] | 49.30[a] | 47.40[ab] | 6.20[b] | 80.47[bc] | 85.10[bc] | 0.945[a] |
| E8755 | 61.44[cd] | 49.84[a] | 47.61[ab] | 6.76[ab] | 82.78[abc] | 85.77[bc] | 0.964[a] |
| BA5445 | 60.57[cd] | 50.66[a] | 48.62[ab] | 6.94[ab] | 89.29[abc] | 95.07[abc] | 0.940[a] |
| F170 | 69.44[b] | 45.51[a] | 4.44[b] | 6.40[b] | 80.70[bc] | 85.47[bc] | 0.955[a] |
| HMX | 60.73[cd] | 52.56[a] | 50.69[a] | 6.87[ab] | 95.53[ab] | 102.33[ab] | 0.934[a] |
| AP533 | 76.21[a] | 50.18[a] | 48.21[ab] | 7.11[ab] | 103.04[a] | 109.00[a] | 0.945[a] |
| CVR | 69.58[b] | 51.67[a] | 49.75[a] | 7.63[a] | 103.65[a] | 110.93[a] | 0.934[a] |
| C.V.[6] | 3.48 | 121.50 | 4.45 | 6.06 | 8.19 | 8.34 | 2.04 |

[1]Means in the same column with different letters differ by Tukey test (P < 0.05); [2]mm; [3]g; [4]mL; [5]g $mL^{-1}$; [6]Coefficient of variation (%). *Tomatoes hybrids H9553 and H9992 were developed by the company Heinz Seed and marketed in Brazil by the company Eagle Comércio de Sementes Ltda.

to longitudinal diameter, probably due to the high coefficient of variation observed (121.50%).

The cultivar F170 presented the smallest transverse diameter (4.44 mm), while cultivars CVR and HMX the largest (49.75 and 50.69 mm, respectively), and others were intermediate (Table 1). Transverse diameter was also positively correlated with the volume (0.71 $p \leq 0.05$), therefore the larger the diameter, the higher the volume. All the fruits were classified as oblong as they presented longitudinal diameter larger than the transverse. The longer oblong fruits are generally preferred over the round fruits by the consumer (Monteiro et al., 2008). For industry, however, the format is not important when the objective is the production of concentrated pulp, but when it is for production of tomato cubes or peeled, the shape is important, being square or oblong tomatoes preferred instead of round.

The pericarp thickness (pulp) was greater in cultivar CVR (7.63 mm) and smaller in cultivars H9992, U2006, F170 and N901 (6.15, 6.39, 6.40, 6.20 mm, respectively), the others did not differ, neither those previously mentioned, with intermediate values. The lowest fruit weight was in the cultivar H9992 (69.53 g), which did not differ from cultivar H9553 and E8755 (Table 1). The pericarp thickness correlated positively with fruit mass and volume (0.81$p \leq 0.01$ and 0.83 $p \leq 0.01$, respectively), so the bigger the fruit, the greater the thickness of the pulp. The fruit weight was higher in cultivars CVR and AP533 which did not differ from the HMX and U2006. Hybrids H9992 and H9553 are already known and so in this research were used to compare the new genetic material presented.

Fruit weight is an important component of production and also an important quality-related parameter since it is a way for indirectly represent the fruit size (Nascimento et al., 2013; Tomas et al., 2017). But there is an industry preference for genotypes that produce smaller fruits, weighing from 50 to 100 g in average, which provides more resistance to transport. In this work, fruits presented values within the range cited by this author, except for cultivars CVR and AP 513 who had higher weight. The fruit volume was higher in cultivars CVR and AP533, which did not differ from cultivars HMX and U206, while the lowest was cultivar H9992 (Table 1).

The density did not differ between different genetic materials. Fruit density may be indicative of maturity stage (Bengozi et al., 2007), decreasing with the advance of maturation (Gouveia et al., 2003). Fruit firmness has often been used as an indicator of quality, as well as in characterizing mechanical, chemical and rheological properties of the fruit (Koetz et al., 2010). The cultivar with highest mechanical resistance of the fruit pulp (RPu) was the H9553. The cultivar U2006 showed the lowest pulp resistance (Table 2).

There was a negative correlation between resistance of the pulp and fruit length (–0.73 $p \leq 0.05$), so the smaller the fruit size, the higher the pulp resistance. Therefore, there is a tendency that smaller fruits generate lower losses in handling during mechanical harvest, and in postharvest (loading, transportation and unloading). H9992, H9553, N901, BA5445 and HNX showed the most resistant pulps and shorter fruits lengths (Tables 1 and 2), so these are more suitable for industrialization. The variation between cultivars may be related to the size and shape of cells, to the sequences of cells and natural deposition of materials on the outer cell walls, which can influence the fruit firmness. Smaller fruits have small cells with little or small intercellular spaces forming a compact texture, whereas larger fruits have large cells with large intercellular spaces forming a spongy texture. Differences in accumulating pectic substances, as well as in total amounts of cell wall materials per unit of tissue and volume should correlate with differences in firmness (Pinto et al., 2003). Peel resistance (RPe) was higher in cultivars BA 5445, H9992, HMX and F170, and lowest in cultivars CVR, U2006, AP533, E8755 and H9553 (Table 2).

Texture of tomatoes is basically reflected by the mechanical properties of the periderm (Harker et al., 1997). Several factors can influence the fruit peel and pulp resistance along different transformations on the fruit during ripening (Nascimento et al., 2013). Firmness loss also depends on the cell wall degradation and loss of tissue turgor. The first is related to increased activity of endogenous enzymes that break down pectic material, such as polygalacturonase and cellulase. The decrease in turgor pressure with water loss or dehydration is caused by respiration and/or transpiration (Reddy et al., 2000).

Chromatic characteristics (a*) and (b*) of cultivars were positive (Table 2), that is, reddish and yellowish tones related to lycopene and carotene pigments, respectively. However, it was noted greater intensity of the red component (a*) than of component (b*), due to the studied fruits were in red color maturity stage. Thus, the parameters that best define the color of tomatoes at this ripening stage are L* and a*, both serving as indicators of the presence of lycopene (Reeve, 1970). The lowest brightness was observed in the fruits of cultivars H9992, H9553 and U2006 (Table 2). The luminosity correlated positively with a* and b* (0.66 and 0.85, respectively). Thus, materials with lower L* value had the highest a* and b*. The coordinate a* did not vary significantly, but all cultivars obtained high a* values. Coordinate a* was negatively correlated with titratable acidity (TA). In this context, for the industry, it would be ideal to use raw materials with high a* and low TA, therefore, among the studied materials, cultivars AP533 and F170 are recommended.

For b*, the lowest values were observed in cultivars U2006, H9992, H9553 and N901 (Table 2). Pigments that reflect light yellow are the carotenes, responsible for higher b* values. The industry prefers genetic materials with reduced L* and b* and elevated a*, due to the red color be more attractive for consumers in products derived from tomatoes (Melo & Vilela, 2005). The b* values correlated positively with L* (0.85 $p \leq 0.01$), so the more yellow, the lighter is the fruit. Therefore, regarding the parameters L* and b*, fruits of cultivars H9992, H9553 and U2006, less yellow and darker, are the most recommended for the industry, which seeks genotypes with higher concentrations of lycopene, and less of carotenes.

The citric acid content in fruits ranged 46.05%. Cultivars N901 (6.28) and AP533 (4.30) differed significantly in relation to total acidity (TA), being other cultivars intermediate (Table 3). TA indicates the amount of organic acids present in tomato fruit, and also astringency, which strongly influence the flavor of the fruits (Romero-Peña & Kieckbush, 2003). In the present work, the evaluated cultivars presented significant acid content, qualifying the fruits as acidic, making them attractive to the market. The acidity of fruits, besides giving characteristic flavor and aroma, interferes with the time of heat treatment on industrial processing (Chitarra & Chitarra, 2005).

There was no significant difference for the hydrogen potential (pH) among ten processing tomato cultivars, and the variation was 5.13% (Table 3). The evaluated cultivars presented

**Table 2**. Peel resistance, pulp resistance and color parameters (L*, a* and b*) of the fruits of ten cultivars of processing tomato, 2011 crop. Morrinhos, Brazil.

| Cultivar[1] | Peel resistance[2] | Pulp resistance[2] | L* | a* | b* |
|---|---|---|---|---|---|
| H9992 | $5.72^{ab}$ | $1.98^{ab}$ | $43.66^{b}$ | $19.30^{a}$ | $0.82^{c}$ |
| H9553 | $5.09^{cd}$ | $2.13^{a}$ | $59.37^{ab}$ | $23.26^{a}$ | $1.20^{c}$ |
| U2006 | $5.06^{cd}$ | $1.14^{e}$ | $69.21^{ab}$ | $30.01^{a}$ | $0.53^{c}$ |
| N901 | $5.43^{bc}$ | $1.78^{abcd}$ | $85.33^{a}$ | $30.08^{a}$ | $5.80^{bc}$ |
| E8755 | $5.07^{cd}$ | $1.54^{bcde}$ | $95.70^{a}$ | $24.83^{a}$ | $11.97^{ab}$ |
| BA5445 | $5.91^{a}$ | $1.80^{abcd}$ | $91.42^{a}$ | $30.61^{a}$ | $12.05^{ab}$ |
| F170 | $5.51^{abc}$ | $1.25^{de}$ | $86.37^{a}$ | $23.78^{a}$ | $11.50^{ab}$ |
| HMX | $5.73^{ab}$ | $1.86^{abc}$ | $86.78^{a}$ | $27.37^{a}$ | $11.33^{ab}$ |
| AP533 | $5.07^{cd}$ | $1.36^{cde}$ | $91.39^{a}$ | $30.78^{a}$ | $17.23^{a}$ |
| CVR | $4.73^{d}$ | $1.62^{bcde}$ | $91.33^{a}$ | $31.41^{a}$ | $14.76^{a}$ |
| C.V.[3] | 3.02 | 12.12 | 15.53 | 19.02 | 29.32 |

[1]Means in the same column followed by different letters differ by Tukey test ($p < 0.05$); [2]N; [3]Coefficient of variation (%).

**Table 3**. Physiochemical characteristics of fresh pulp of ten cultivars of processing tomato cultivars, crop 2011. Morrinhos, Goiás, Brazil.

| Cultivar[1] | TA (% citric acid) | pH | SS (°Brix) | SS/TA |
|---|---|---|---|---|
| H9992 | $5.87^{ab}$ | $4.30^{a}$ | $4.23^{bc}$ | $0.73^{abc}$ |
| H9553 | $5.20^{ab}$ | $4.37^{a}$ | $4.05^{cd}$ | $0.81^{abc}$ |
| U2006 | $5.95^{ab}$ | $4.35^{a}$ | $4.64^{ab}$ | $0.78^{abc}$ |
| N901 | $6.28^{a}$ | $4.29^{a}$ | $3.73^{ed}$ | $0.59^{c}$ |
| E8755 | $5.57^{ab}$ | $4.29^{a}$ | $3.82^{dce}$ | $0.69^{abc}$ |
| BA5445 | $5.74^{ab}$ | $4.29^{a}$ | $3.53^{e}$ | $0.62^{bc}$ |
| F170 | $4.54^{ba}$ | $4.51^{a}$ | $4.22^{bc}$ | $0.95^{a}$ |
| HMX | $5.21^{ab}$ | $4.31^{a}$ | $4.86^{a}$ | $0.94^{ab}$ |
| AP533 | $4.30^{b}$ | $4.34^{a}$ | $3.60^{ed}$ | $0.85^{abc}$ |
| CVR | $4.83^{ab}$ | $4.44^{a}$ | $3.95^{dce}$ | $0.85^{abc}$ |
| C.V.[2] | 12.53 | 1.73 | 4.02 | 14.31 |

[1]Means in the same column followed by different letters differ by Tukey test ($p < 0.05$); [2]CV: coefficient of variation (%).

mean pH values within the variation range considered ideal for tomatoes with acceptable quality, whose desirable pH is lower than 4.50 and higher than 3.70 for not having high acidity (Giordano et al., 2000). The pH value becomes very important when the fruit is intended for processing, since pH below 4.50 is desirable to prevent the growth of microorganisms while pH values above 4.50 require longer periods of sterilization of raw material during thermal processing, resulting in higher energy consumption and higher processing costs (Melo & Vilela, 2005). Tomato industry wants the pH of the raw tomato pulp lower than 4.50, to hinder the growth of microorganisms in the final products and save energy used in heat treatment.

HMX and U2006 cultivars showed higher soluble solids (SS) (4.86 and 4.64 °Brix, respectively) fallowed by H9992 (4.23 °Brix), with a small variation of 4.74% between them, thus did not show significant difference (Table 3). The lowest values of SS were found in cultivars BA5445, AP533, H9553, E8755, N901 and CVR. Weather conditions interfere in soluble solids. The SS content varies according to the cultivars and climatic conditions, rains can reduce the SS content (Goto & Tivelli, 1998; Resende et al., 2010), and during the maturation of fruits there was a rainy period, which interfered with the reduction of the SS of these cultivars.

The SS is one of the main characteristics of tomato fruits with regard to industrial yield, since it is this fraction that contains sugars and acids (Sampaio & Fontes, 1998), and the most abundant constituent of dry matter of the fruits. The soluble solids content is an important characteristic, as it indicates the yield in processed tomato pulp. In this way, each degree Brix increase in raw material represents an increase of 20% in industrial yield (Giordano et al., 2000). Besides the acidity, the taste of tomato fruit and tomato paste is largely determined by the content of soluble solids and volatile compounds (Shirahige et al., 2010). The values of soluble solids were low in the present study, probably due to the methodology used in the processing of the fresh pulp, the peeling used in the process was manual and the tomatoes were cooled in cold water after heat treatment. Due to the large amount of tomatoes used in the experiment, fruits lasted for 15 to 20 min in immersion, which may have increased the loss of solids in the water. If the process was faster, the SS values obtained would probably be higher. Moreover, another aspect that might have underestimated the soluble solids content was the removal of the most concentrated SS region of tomatoes in the manual peeling along with the fruit peel.

The SS/TA ratio ranged 61.02%. The cultivars N901 and BA5445 presented the lowest values of SS/AT, and cultivars F170 and HMX the highest (Table 3). SS/TA or maturation index is widely used as indicator of fruit palatability (Chitarra & Chitarra, 2005).

The tomato flavor is related to the presence of a number of chemical constituents, especially sugars and acids. Therefore, the SS/TA ratio is an important characteristic for flavor evaluation, being more representative than the isolated measurement of sugars and acidity (Pinto et al., 2003). According to Ferreira et al. (2010), a high SS/TA determines a mild taste due to the excellent combination of sugar and acid, whereas low values are related to TA and unpleasant taste or astringent, indicating a product suitable for processing. The values of SS/TA ratio in this study were low, attribute that industries want in processing tomatoes.

## 4 Conclusions

The cultivars H9992, H9553, BA5445, and HMX N901 have smaller fruits (length, volume and mass) and a higher mechanical resistance of the fruit pulp. The cultivars H9992, HMX and F170 also have greater resistance of the fruit peel, indicating that these materials are less susceptible to losses during mechanical harvesting and transportation to the industry. The cultivars HMX and U2006 have higher soluble solids content fallowed by cultivar H9992, and potential to enable high industrial yield. While the cultivars H9992, H9553 and U2006 showed a darker color, directly correlated with the red color. Therefore, the new genetic material that presented better quality characteristics for industrialization is HMX, standing out positively in most of the evaluated parameters.

## Acknowledgements

The CAPES for financial support, and Embrapa Hortaliças that conducted the field experiment and providing tomato samples.

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