MENEZES, K. R. P; SANCHES, A. G; SANTOS, G. C. de. S; OLIVEIRA, A. R. G. de; CORDEIRO, C. A. M. Physicochemical and sensorial characterization of table tomato cultivars. **Pesquisa Aplicada & Agrotecnologia,** Guarapuava-PR, v.11, n.3, p.07-20, sep-dec., 2018. DOI: 10.5935/PAeT.V11.N3.01

Scientific Paper

Physicochemical and sensorial characterization of table tomato cultivars

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Abstract

The objective of this work was to characterize the physicochemical and sensorial quality of the post-harvest quality of three table tomato cultivars marketed in the local market of Altamira-PA in order to identify which cultivar presents the smallest physiological changes and better consumption conditions over of storage time. The physical-chemical parameters analyzed were: loss of fresh mass, total soluble solids, titratable total acidity, pH, SST / ATT ratio and sensorial analysis on firmness, peel color, general quality and incidence of rot. The experiment was conducted in a completely randomized design under a 5x3 factorial arrangement (storage days x cultivars) with four replicates. With the exception of the rotting variable, all the variables analyzed showed a significant effect at the 1 and 5% probability level in the interaction of the days storage factors and cultivars. In general, it can be observed that the evaluated cultivars present slight differences in their physico-chemical and sensorial constitution that compromise their quality and useful life. The physiological changes of greater expressiveness were obtained by the fruits of the cultivar Santa Adélia, which suggests a consumption and commercialization in a few days given the low tolerance to storage in the condition of ambient temperature. The fruits of the cultivar TY were resistant to physical-chemical and sensory changes induced by ripening and were therefore recommended for commercialization and consumption. Principal component analysis ratifies this effect by correlating a greater number of variables to TY cultivar and none to Santa Adélia cultivar.

Key Words: *Lycopersicum esculentum* Mill. post-harvest. commercialization.

Resumo

Caracterização físico-química e sensorial de cultivares de tomate de mesa

O objetivo deste trabalho foi caracterizar físico-química e sensorialmente a qualidade pós-colheita de três cultivares de tomate de mesa comercializadas no mercado local de Altamira-PA com o intuito de identificar qual cultivar apresenta as menores alterações fisiológicas e melhores condições de consumo ao longo do tempo de armazenamento. Os parâmetros físico-químicos analisados foram: perda de massa fresca, sólidos solúveis totais, acidez total titulável, pH, relação SST/ATT e análise sensorial sobre os atributos firmeza, coloração da casca, qualidade geral e incidência de podridões. O experimento foi conduzido em um delineamento inteiramente casualizado sob um arranjo fatorial 5x3 (dias de armazenamento x cultivares) com quatro repetições. Com exceção da variável podridão, todas as variáveis analisadas apontaram efeito significativo ao nível de 1 e 5% de probabilidade na interação dos fatores dias de armazenamento e cultivares. De modo geral pode-se observar que as cultivares avaliadas apresentam ligeiras diferenças na sua constituição físico-química

Received at: 01/03/2018 Accepted for publication at: 26/08/2018

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Brazilian Journal of Applied Technology for Agricultural Science, Guarapuava-PR, v.11, n.3, p.07-20, 2018

e sensorial que comprometem sua qualidade e vida útil. As alterações fisiológicas de maior expressividade foram obtidas pelos frutos da cultivar Santa Adélia a qual sugere-se um consumo e comercialização em poucos dias dada a baixa tolerância ao armazenamento na condição de temperatura ambiente. Os frutos da cultivar TY mostraram-se resistente as alterações físico-químicas e sensoriais induzidas pelo amadurecimento sendo, portanto, recomendados para a comercialização e consumo. A análise de componentes principais ratifica esse efeito, correlacionando um número maior de variáveis a cultivar TY e nenhuma a cultivar Santa Adélia.

Palavras-chave: *Lycopersicum esculentum* Mill. pós-colheita. comercialização.

Resumen

Caracterización físico-química e sensorial de cultivares de tomate de mesa

El objetivo de este trabajo fue para caracterizar el físico y la sensorial calidad de la post-cosecha de la calidad de la mesa de la mesa de los cultivares marketed en el mercado local de Altamira-PA para identificar qué cultivar presenta los cambios de poco tiempo y las condiciones de consumo tiempo de almacenamiento. Los parámetros de los parámetros físicos y físicos fueron: pérdida de grasa, solubilidad total, titratable total acidity, pH, SST / ATT ratio y sensorial análisis sobre firmeza, peel color, general quality y incidencia de la putrefacción. El ensayo se inició en un aleatoriamente de diseño bajo a 5x3 factorial de acuerdo con los días de descanso. Con la excepción de la etiqueta de la variable, todas las variables se muestran a un efecto secundario en el nivel 1 y el 5% de nivel alto en la interacción de los días de almacenamiento de datos y cultivares. En general, se puede observar que el análisis de los cultivares presenta diferencias ligeras en su constitución físico y sensorial constitucional que compromie su calidad y la vida útil. En el caso de los cultivares de Santa Adélia, que se basó en el consumo y la comercialización en unos días debido a la baja tolerancia al almacenamiento en la condición de la temperatura ambiente. Las raíces de la cultivar TY fueron resistentes a los peligros físicos y los cambios sensibles detectados y se recomendaron para la comercialización y el consumo. El principal componente de análisis ratificó este efecto por correlación a un número mayor de variables a TY cultivar y no a Santa Adélia cultivar.

Palabras clave: *Lycopersicum esculentum* Mill. después de la cosecha. comercialización.

Introduction

The tomato (*Lycopersicum esculentum* Mill) is an herbaceous plant with annual cycle, belonging to the Solanaceae family, with ease of adaptation to a great variety of climates (ROSA et al., 2011). It is one of the main olerícolas, which plays an important role in the economy (SHIRAHIGE et al., 2010).

The tomato is a fruit rich in vitamins A and C and mineral salts such as potassium and magnesium (MELO et al., 2014). It is used in the in natura form, mainly in salads, consisting of the most consumed culture in the world (BINOTI et al., 2013).

According to Lemos et al. (2007), the fruits of the tomato are sensitive to the handling and several are the problems related to their conservation, that occurs from the moment of the harvest, when initiates a series of processes that influence in the quality of the product and its consequent losses, until it reaches the consumer.

The quality of the fruit is affected by the post-harvest conservation practices, so the understanding of the processes that occur during the maturation of the table tomato and the quality characteristics of the fruits in the storage are fundamental for the commercialization (FERREIRA et al., 2010; MODOLON et al., 2012).

During maturation of the tomato, physiological and biochemical changes, such as changes in color, texture and flavor, induce changes in fruit quality, which are directly linked to the genetics of tomato hybrids and the constant fruits suffer during their development (FERREIRA et al., 2012). These changes in the physical-chemical characteristics of the fruit are important because they define the quality of the fruits (SOUSA et al., 2011).

In this context, the present work aims to characterize the post-harvest quality of three table tomato cultivars marketed in the city of Altamira-PA in order to determine which physiological characteristics result in a longer period of marketing and better consumption conditions over the time of storage.

Material and methods

The present research was carried out with table tomatoes of the cultivars (Tinto, Santa Adélia, and TY), belonging to the saladete group, presenting fruits with an average size of 7 to 10 cm with thick and intense reddish flesh, very firm and tasty. Harvested on agricultural property that exploit the tomato crop under a commercial production regime in the municipality of Altamira-PA. The fruits of each cultivar were harvested in the morning at a stage of physiological maturation attained I, characterized by a totally "green" periderm. In order to standardize the fruits of each cultivar, they were selected for uniformity of size, bark color, absence of mechanical and physiological damages or affected by pests and diseases.

The tomatoes were packed in thermal boxes and transported to the Laboratory of Chemistry of the Federal University of Pará, Campus Altamira, PA, where they were first submitted to washing in running water for the removal of the soils coming from the field followed by sanitization in a solution containing sodium hypochlorite to 200 mg L^{-1} for 5 min, then these were placed on benches and dried in room temperature condition.

Storage was carried out at room temperature (25 ± 2 ° C and 85 ± 5% U.R), simulating the conditions of commercialization at the retail outlets for a period of 12 days with evaluations of the physico-chemical variables and sensorial tests performed at three-day time intervals.

Fresh mass loss (FML) determined using a semi-analytical balance with a precision of 0.2 g was calculated by calculating the difference between the initial weight and the final weight of the fruits on each day of the evaluation using the following expression: FML = (MFI - MFF) × 100, where, FML, loss of fresh mass (%); MFI, initial fresh mass (g); MFF, final fresh mass (g), and the results will be expressed as a percentage (%).

The total soluble solids content (TSS) was obtained by direct reading in a portable digital refractometer of the brand ATAGO PR-101 using 10 g of the sample macerated and filtered according to AOAC recommendations (2012) and the results expressed in ° Brix.

Titratable total acidity (TFA) was determined by weighing 10 g of tomato pulp and adding 100 mL of distilled water. This solution was titrated with 0.1M NaOH standard solution and 1% phenolphthalein (m/v) as a turning point according to the methodology described by AOAC (2012), the results being expressed as (%) citric acid.

The pH was obtained by direct reading in the crushed pulp in a TECNAL brand, which was duly calibrated in buffer solution 4.0 and 7.0 according to AOAC (2012).

The ratio (SST / ATT) was determined from the ratio between the two dividing SST by the ATT values.

The sensorial evaluation of the fruits was done by assigning notes in a hedonic scale of five points (Table 1) as proposed by AOAC (2012).

Table 1. Sensory evaluation on firm attributes, bark color, odor, general quality and incidence of rot in fruits of different table tomato cultivars.

Firmness	Shell coloring
5. Firm	5. Green
4. Moderately Firm	4. Green with yellow dashes
3. Slightly firm	3. Yellow
2. Little soft, soft	2. Yellow with orange traces
1. Mole, soft	1. Red
Overall quality	**Incidence of rot**
5. Excellent, free of defects	5. 0% rot
4. Good, small defects	4. Up to 5% of affected fruits
3. Average defects, do not limit consumption	3. Up to 25% of affected fruits
2. Excessive defects, limited consumption	2. Up to 50% of affected fruits
1. Rotten, not usable	1. More than 50% of affected fruits

The experimental design was completely randomized in a 5x3 factorial arrangement: (five storage times: 0, 3, 6, 9 and 12 days) and (three tomato cultivars: Santa Adélia, Tinto and TY). Each treatment was composed of four replicates and the experimental plot consisted of two fruits.

The data were submitted to analysis of variance (ANOVA) and the comparison of means by the Tukey test at the level of 5% of significance through software Assistat 7.7 beta. For the multivariate analysis, data of all variables were self-staggered using the Excel program (2010) and submitted to the main component analysis (PCA) through the STATISTIC 7.0 Software.

Results and discussion

According to the ANOVA data by the F test presented in Table 1, it was observed that there was a significant effect between the isolated factors (days and cultivars) and their interaction (days x cultivars) at the 1% probability level on the variables (TSS), total titratable acidity (ATT), pH and ratio (TSS/ATT).

Table 2. Summary of the analysis of variance by the F test on the physicochemical variables of: loss of fresh mass (FWL), total soluble solids (SST ° Brix), titratable total acidity (ATT g $100g^{-1}$ citric acid), pH and relation (TSS/ATT), depending on storage days, tomato cultivars and the interaction between these factors.

Sources of variation	Analysis table					
	GL	PMF	TSS	ATT	pH	SST/ATT
Days	4	132,29**	380,28**	439,01**	143,41**	220,74**
Cultivars	2	150,92**	146,27**	130,01**	138,63**	421,65**
Int. Days x Cultivars	8	249,06**	45,50**	35,65**	31,22**	167,13**
Treatment	14	41,25**	155,55**	164,37**	84,21**	78,66**
Residue	45	0,02	0,06	0,001	0,03	0,05
CV (%)=	-	2,32	1,78	4,25	0,89	2,34

** significant at the 1% probability level (p <0.01); * significant at the 5% probability level (0.01 = <p <0.05); ns = not significant (p> = 0.05).

In this work, the loss of fresh weight had a significant effect (p <0.05) among the evaluated cultivars, possibly influenced by the physiological and genotypic differences presented Figure 1.

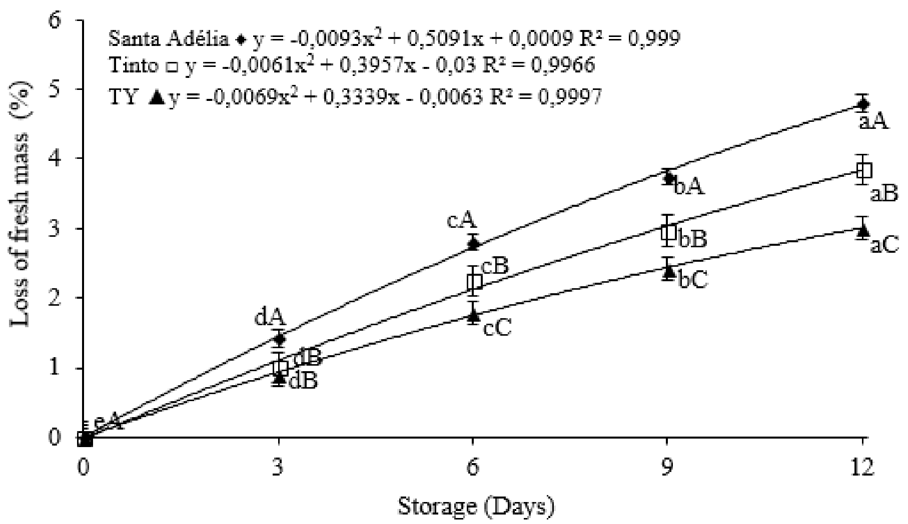

Figure 1. Fresh mass loss (%) in table tomato cultivars during 12 days of storage under ambient temperature conditions (25 ± 2 ° C and 85 ± 5% of U.R). Lower case letters (storage days) and upper-case letters (cultivars) do not differ from each other by the Tukey test at the 5% probability level.

In general, the loss of fresh mass increased progressively throughout the evaluation days in all the cultivars, probably the storage in environment condition impelled a higher rate of perspiration of the fruits, favoring this loss of fresh mass that oscillated between 3.11 to 4, 55% among cultivars (Figure 1). These percentages corroborate with those observed by Chiumarelli and Ferreira (2006) and Oliveira et al. (2011) that in evaluation with table tomatoes during twelve days in ambient condition obtained average percentages of 3.85% to 4.76%, respectively.

Among the cultivars, it was observed that Santa Adélia obtained the highest percentages of loss mainly after the third day of storage reaching a mean of 4.55% at the end of twelve days of analysis (Figure 1). This cultivar is characterized by small and sensitive fruits (fine periderm), which probably contributes to the greater perspiration of the fruits and favors this result.

The Tinto and TY cultivars showed the lowest losses of fresh mass during storage differing only in the last day of evaluation when the average percentage was 3.95% and 3.11%, respectively (Figure 1). These low percentages are similar to those observed by Ferreira et al. (2010) that when evaluating the post-harvest quality of table tomatoes cv. Raísa in conventional cultivation and cv. Santa Clara in organic cultivation obtained an average percentage of 3.74% during 12 days of storage.

A factor that may have contributed to the lower loss of fresh mass in the cultivars Tinto and TY may be related to the genetic improvement of these that are characterized by presenting fruits more resistant to pests and diseases and firmer physiologically, thus allowing a lower transpiration rate and consequently less water loss during the gas exchanges with the medium.

The content of total soluble solids (TSS) presented variations among tomato cultivars as an advance in storage time (Figure 2). This fact is justified by Ramos et al. (2013) where the soluble solids content is influenced by fertilization, temperature, irrigation and, mainly, by the genetic characteristics of the cultivar.

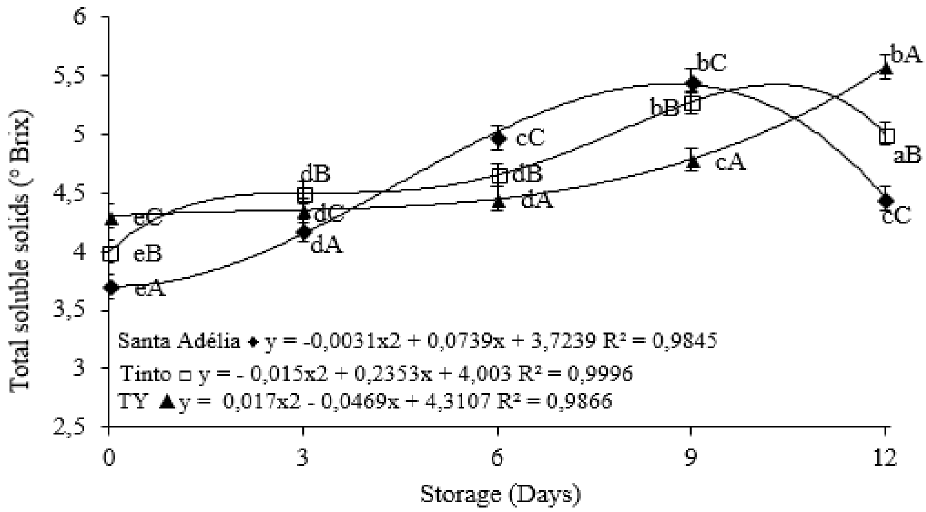

Figure 2. Variation in the content of total soluble solids (° Brix) in table tomato cultivars during 12 days of storage under ambient temperature conditions (25 ± 2 ° C and 85 ± 5% of U.R). Lower case letters (storage days) and upper-case letters (cultivars) do not differ from each other by the Tukey test at the 5% probability level.

Analyzing Figure 2, there is a tendency for a progressive increase in the TSS contents in the cultivars Santa Adélia and Tinto until the ninth day of storage with a later reduction at the end of twelve days with average contents of 4.45 and 4.85 ° Brix , respectively. On the other hand, the cultivar TY presented stability until the sixth day of storage followed by a more pronounced increase until the last day of evaluation with a mean value of 5.57 ° Brix, differing from the others (Figure 2).

Oshiro et al. (2012) explain that during fruit storage the soluble solids contents tend to increase with maturation due to the loss of pulp mass and the hydrolysis of the starch in glucose that concentrates them during ripening. The reduction of these levels in turn is justified by the consumption in the respiratory metabolism of the fruit itself, being an indication of senescence. Behavior was observed in the cultivars Santa Adélia and Tinto after nine days of storage (Figure 2).

Independently of the storage time, the maximum SST levels observed in the pulp of the tomatoes with the ripening process were 5.37, 5.55 and 5.57 for the cultivars Tinto, Santa Adélia and TY, respectively (Figure 2), indicating in this way greater relation with the flavor (sweetness) of the fruits. These values are close to those reported by Rosa et al. (2011), whose highest SST content in two tomatoes accesses ranged from 5.25 to 5,30 ° Brix and by Marodin et al. (2016) that when evaluating table tomatoes of the cultivar " Kada gigante " verified a content of 5,18 ° Brix.

There was a significant effect ($p < 0.05$) on the titratable acidity content observed in the pulp of the tomato cultivars over the storage time (Figure 3). Resende et al. (2010) and Nunes et al. (2011) also observed a significant variation in titratable acidity levels in different onion and pumpkin cultivars, respectively, and justified this variation in function of the genetic characteristics of each material, the response to the management of the fertilization as well as the adaptation of the climate and soil conditions.

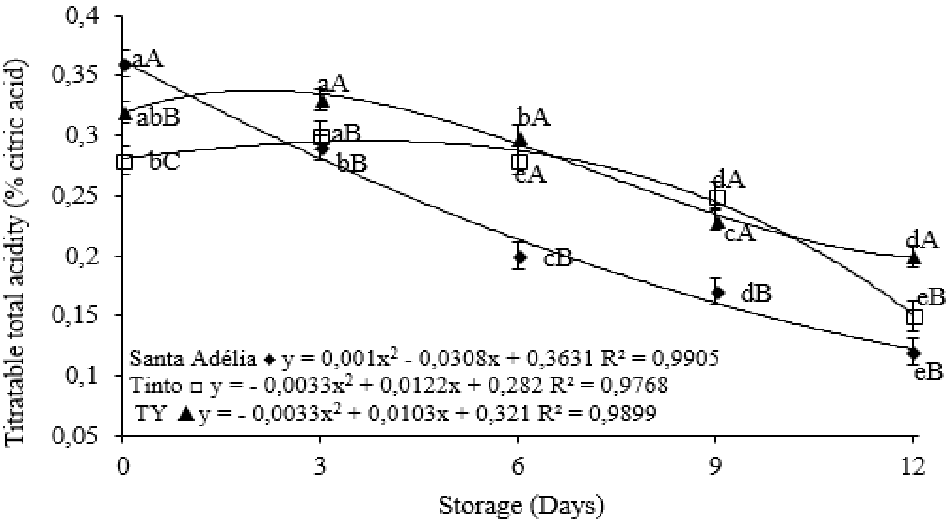

Figure 3. Titratable total acidity (% citric acid) contents in table tomato cultivars during 12 days of storage under ambient temperature conditions. (25 ± 2 ° C and 85 ± 5% U.R.). Lower case letters (storage days) and upper case letters (cultivars) do not differ from each other by the Tukey test at the 5% probability level.

The percentage of titratable acidity (citric acid) decreased with storage time, independent of the evaluated cultivar (Figure 3). Similarly, Sandri et al. (2015) and Oliveira et al. (2015) also found a decrease in mean values of acidity in cherry tomatoes of the cultivar Swet grape with storage time.

In the case of a climacteric fruit, such as tomato, where the respiratory activity is elevated, induced by the increase in the ethylene production rate, this reduction was already expected since the organic acids tend to decrease with storage time at as they are breathed or converted into sugars with the advancement in ripening (CHITARRA and CHITARRA, 2005).

The genetic variability between the cultivars promoted different values of acidity at the zero evaluation time with mean values ranging from 0.31 to 0.38% of citric acid (Figure 3). These percentages are well above that reported by Oliveira et al. (2016) whose average citric acid content in the table tomato pulp was 0.24% and close to those verified by Costa et al. (2012) and Santos Neto et al. (2016) in table tomatoes whose zero storage percentages were 0.41 and 0.30% citric acid, respectively.

According to Figure 4, it can be observed that the mean values of pH between the cultivars showed significant variations with a tendency of increase as the storage time progressed. Chitarra and Chitarra (2005), explain that this increase is caused by the intense respiratory process induced by the fruit ripening process.

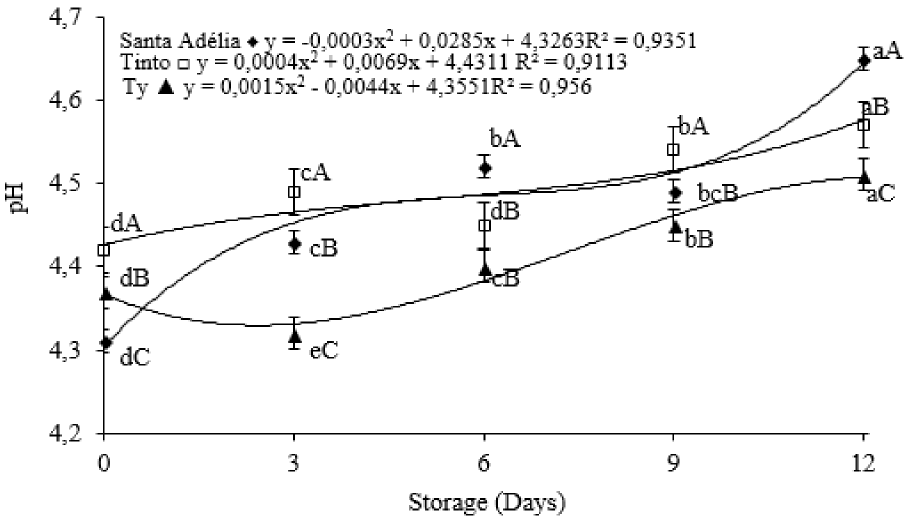

Figure 4. Oscillation in mean pH values in table tomato cultivars over 12 days storage at room temperature (25 ± 2 ° C and 85 ± 5% U.R).) and uppercase (cultivars) do not differ from each other by the Tukey test at the 5% probability level.

At day zero of the evaluation the average values presented between cultivars ranged from (4.37 to 4.42) reaching (4.51 to 4.67) after twelve days of storage (Figure 4). These values corroborate with those verified by Campos et al. (2015) evaluating "Pitenza" table tomatoes under refrigeration conditions at 12 ° C showed an increase in values with storage time going from 4.32 on day zero to 4.65 at the end of 21 days. On the other hand, the pH values (4.03 to 4.20) verified by Barankevicz et al. (2015) in two hybrids of table tomatoes presented well below those of this research. This fact can be attributed to the physiological characteristic of the hybrids and especially to the condition of storage of the fruits that was at 0 ° C.

Still according to Figure 4, it can be observed that the cultivars Santa Adélia and Tinto, in addition to presenting greater variations, also showed a more pronounced increase at the end of the storage period. According to Chitarra and Chitarra (2005) pH is an indication of deterioration of the product because it indicates acidification with senescence observing increase or stabilization of the values with storage time. In this context, the cultivars Santa Adélia and Tinto presented a higher maturation / senescence stage induced mainly by the increase in ethylene synthesis, when compared to cultivar TY, whose pH values were less pronounced with storage days (Figure 4).

As titratable acidity and soluble solids are important factors related to the degree of maturation and taste of foods, 'Ratio', a relation that corresponds to the sugars and acidity contents of the fruits and is an appropriate parameter to measure the perception of flavor and degree of maturation (IENSEN et al., 2013).

Paula et al. (2015) evaluating the physical-chemical characterization in five stages of maturation of table tomato genotypes verified average values ranging from 6,55 to 15,61. In the present work, values ranged from (5,09 to 7,83) on day zero to (12,75 to 15,85) among cultivars, the latter values being that the fruits were completely red, indicating a higher ratio of flavor and consequently ripening (Figure 5).

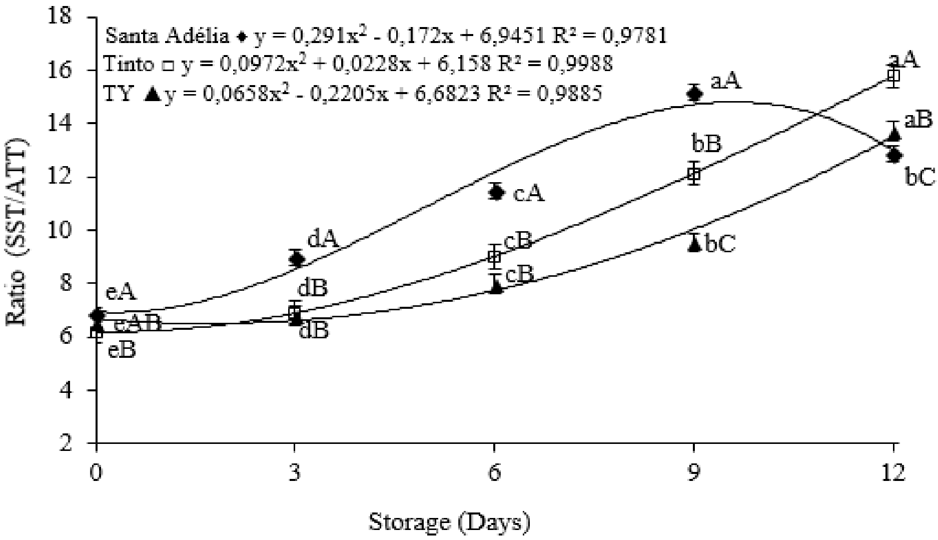

Figure 5. Ratio (TSS/ATT) in table tomato cultivars over 12 days storage at room temperature (25 ± 2 ° C and 85 ± 5% U.R). Lower case letters (storage days) and upper case letters (cultivars) do not differ from each other by the Tukey test at the 5% probability level.

In relation to cultivars and storage days, it was observed that the cultivars Santa Adélia and Tinto had the highest values until the ninth day of storage followed by stabilization indicating a better relationship in the flavor balance between sugars and organic acids in the fruit pulp and consequently a higher maturation stage differing significantly from the fruits of TY cultivar whose low values during storage days and increase on the twelfth day indicate a fruit with less pronounced maturation physiology (Figure 5).

Table 2 presents the summary of the analysis of variance on the sensory variables evaluated. It was observed that the incidence of rot was the only one that did not present a significant effect on the interaction between storage days and cultivars (p> 0.05), differing only when the isolated effect of the cultivars was analyzed (p <0.05). Peel color, firmness of fruits and overall quality showed a significant effect at 1% when the interaction between the days and cultivars factors was analyzed.

Table 3. Summary of the analysis of variance by the F test on the sensory variables of peel color (PC), fruit firmness (FF), general quality (QG) and incidence of rot (IR) as a function of storage days, tomato cultivars and the interaction between these factors.

Sources of variation	Analysis table					
	GL	PC	FF	QG	IR	SST/ATT
Days	4	110,97**	60,22**	39,20**	2,25 ns	220,74**
Cultivars	2	37,38**	24,68**	21,00**	9,81**	421,65**
Int. Days x Cultivars	8	3,87**	3,16**	2,95**	1,45 ns	167,13**
Treatment	14	39,25**	22,55**	15,90**	2,87**	78,66**
Residue	45	0,23	0,29	0,2	0,26	0,05
CV (%)=		4,07	4,34	6,5	6,83	2,34

** significant at the 1% probability level (p <0.01); * significant at the 5% probability level (0.01 = <p <0.05); ns = not significant (p> = 0.05).

The results are presented in Table 6 (A, B, C, and D), respectively, showing the behavior of table tomato cultivars in relation to peel color, fruit firmness, general quality and rot incidence throughout storage days.

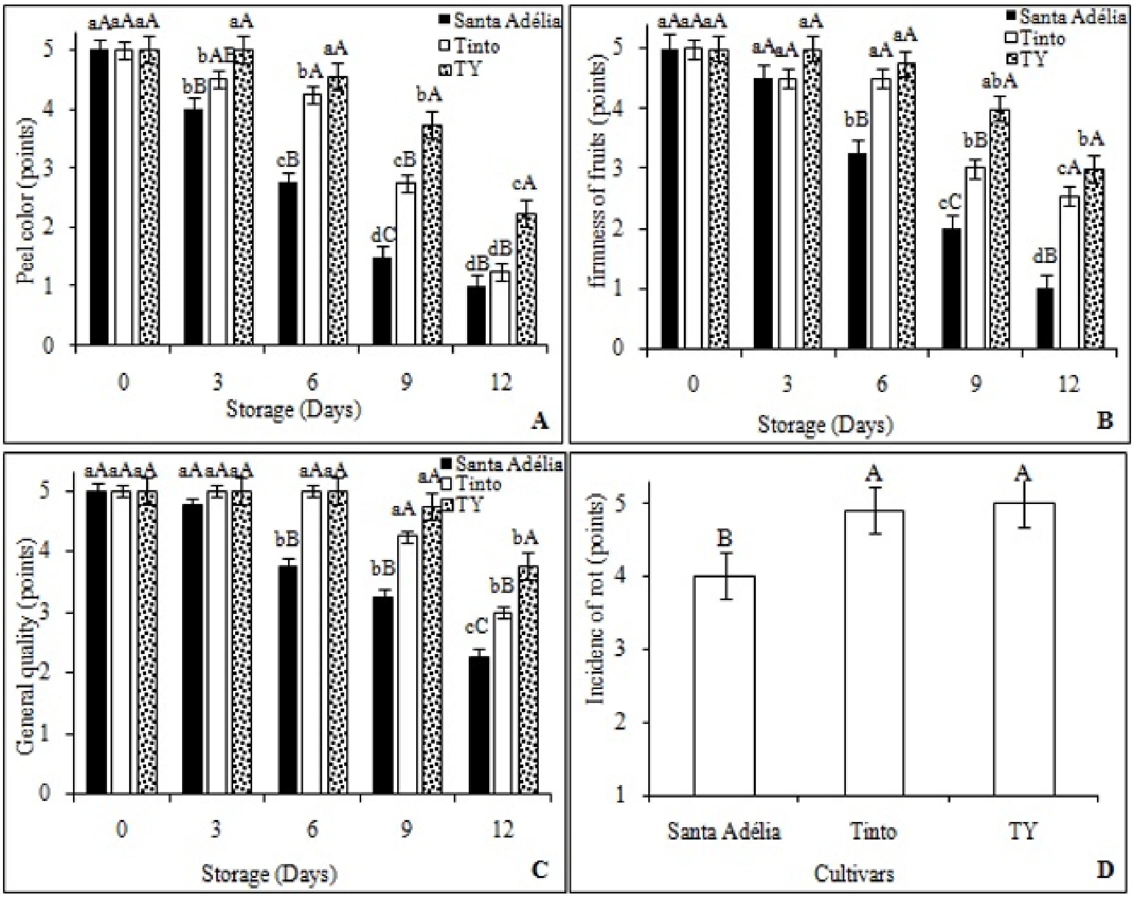

Figure 6. Index of notes on the color of the peel (A), firmness of the fruits (B), general quality (C) and incidence of rot (D) on table tomato cultivars during 12 days storage in (25 ± 2 ° C and 85 ± 5% of U.R.). Lower case letters (storage days) and upper-case letters (cultivars) do not differ from each other by the Tukey test at the 5% probability level.

Regarding the color of the bark, it is noticed that the degradation of the chlorophyll associated with the green color of the fruits occurred in all the cultivars soon after three days of storage (Figure 6A). According to Santos Neto et al. (2016) tomato, as climacteric fruit when harvested physiologically mature still in the green stage, undergoes profound changes in the ripening phase, modulated by ethylene. The degradation of chlorophyll and the synthesis of pigments such as carotenoids and yellow flavonoids that characterize the red color of tomatoes are modifications triggered by ethylene production during storage (MONTEIRO et al., 2008).

In the cultivar Santa Adélia we noticed the greatest changes in the color of the bark influenced by the ripening process, since on the sixth day of storage the assigned mark was 3 characterizing the fruits with yellow coloration. At the same time of evaluation the cultivars Tinto and TY presented scores superior to 4,0 characterizing them as green with yellow traces, respectively (Figure 6A).

At the end of twelve days, only the cultivar TY showed yellow-colored peel coloration with orange traits characterized with a 2.25 mark. In the cultivars Santa Adélia and Tinto, the fruits presented predominantly intense red coloration characterized with notes 1 and 1.25, respectively (Figure 6A).

For Shami and Moreira (2004) from the perspective of the consumer the color is an essential parameter to classify the tomato, being able to represent practically the measure of total quality of the fruit since it associates certain characteristics of color with freshness and healthy product. In this context, the cultivar TY presented a lower synthesis of pigments related to the changes in the color of the bark induced by ripening compared to the cultivars Santa Adélia and Tinto, and therefore presented higher total quality from the perspective of the consumer due to this delay of maturation, prolonging their shelf life .

Evaluating four table tomato cultivars Rosa et al. (2011) also noticed different changes in fruit bark color and the authors associated these differences with the genetic compliance of each cultivar during post-harvest storage, similar to the one verified in this study.

The firmness of the fruits is important for the final consumer, because the choice of tomatoes is made by color, but also by probing the fruit, where the consumer can perceive the level of maturation (CANDÉO et al., 2016). Besides being essential in the useful life of the fruits, as it confers resistance to post-harvest damages (EMBRAPA, 2006).

Figure 6 B shows the firmness indexes in the different table tomato cultivars evaluated over twelve days of storage. In general, it is noticed that as the fruits mature, the decrease of the firmness indexes, associated to the changes in the texture of the fruits and the softening of the pulp occurs.

Santos et al. (2016) observed the reduction in firmness values throughout the storage, due to the reactions of both synthesis and degradation of the components of the cell wall and to the loss of tissue turgidity in the tissue with the advancement of maturation. Another factor associated with this sensorial loss of firmness consists of the squeezing caused by the constant squeezing of consumers that structures ethylene production (BARBOSA et al., 2012).

The cultivar Santa Adélia presented the greatest changes in the firmness attribute, being characterized with a note 1.25 (soft, soft) on the last day of storage, influenced mainly by the advanced stage of fruit maturation, induced by ethylene production. For the same evaluation period, the cultivars Tinto and TY presented grades close to 3.0, characterizing them as slightly firm, not differing from each other (Figure 6B).

Paula et al. (2011) evaluating organic tomato fruits, also verified that the fruits of the San Vito hybrid are more firm than the fruits of the Duradoro cultivar in the three maturation stages, associating that the fruits of salty-type materials are more firm, considering genetic factors and of peculiar improvement to this group.

The general quality is associated with the external appearance of the fruits such as coloring, size, occurrence of damages among others is the most important quality factor from a marketing point of view, since the appearance of the fruit is the first attribute that draws attention of the consumer (TOMAZ et al., 2009; ANESE and FRONZA, 2015).

According to Figure 6C it is observed that the quality index in the Tinto and TY cultivars was characterized as 5.0 (excellent) for up to six days of storage. However, only the cultivar TY presented a better quality aspect at the end of 12 days, differing from the others when it was characterized with a grade of 3.85 (good, small defects), while the Tinto cultivar presented grade 3.0 (mean defects, consumption).

In the fruits of the cultivar Santa Adélia, the lowest quality notes were observed after three days of storage, showing that the evolution of maturation interfered in the general quality of the fruits, since the note marked on the last day of evaluation was 2.25 (defects excessive consumption, limits consumption) (Figure 6 C).

Tomaz et al. (2009) evaluating the post-harvest quality of different hybrids of yellow melon noticed that the external appearance of the hybrid fruits was in excellent conditions for commercialization, since the average is very close to the maximum score (5.0), as verified in this research for the cultivar TY. This fact may be associated with the genetic characteristics of the latter, which are characterized by firmer fruits, conferring higher quality from the consumer perception.

Regarding the incidence of rot (Figure 6D) there was a significant effect ($p < 0.05$) only in relation to the cultivars. The sanitization of the fruits and the packing in a clean and sanitized place contributed to the low occurrence of rot during the storage time.

The fruits of the cultivars Tinto and TY did not differ among themselves and were characterized with a mean score of 4.85, that is, less than 5% of incidence of rot. On the other hand, the fruits of the cultivar Santa Adélia showed the highest incidence of rot mainly influenced by the stage of maturation in which the fruits were being characterized with a mean score of 4.0 (5% of rot).

Oliveira et al. (2016) state that fruits are high in water and nutrients and, even after harvesting until senescence, they maintain several biological processes in activity, thus presenting a greater predisposition to physiological disturbances, mechanical damage and the occurrence of rot. Behavior is more evident in the fruits of the cultivar Santa Adélia.

From the variables represented in the analysis of main components (Figure 7), it is possible to verify that the total factors of data variability explain 80.06%, PC 1 was responsible for 68.28% and PC2 was responsible for 12.32%. This percentage is considered good since at least 70% of the total variance must be explained by the first and second main components (RENCHER, 2002; HONGYU, SANDANIELO and OLIVEIRA JUNIOR, 2015).

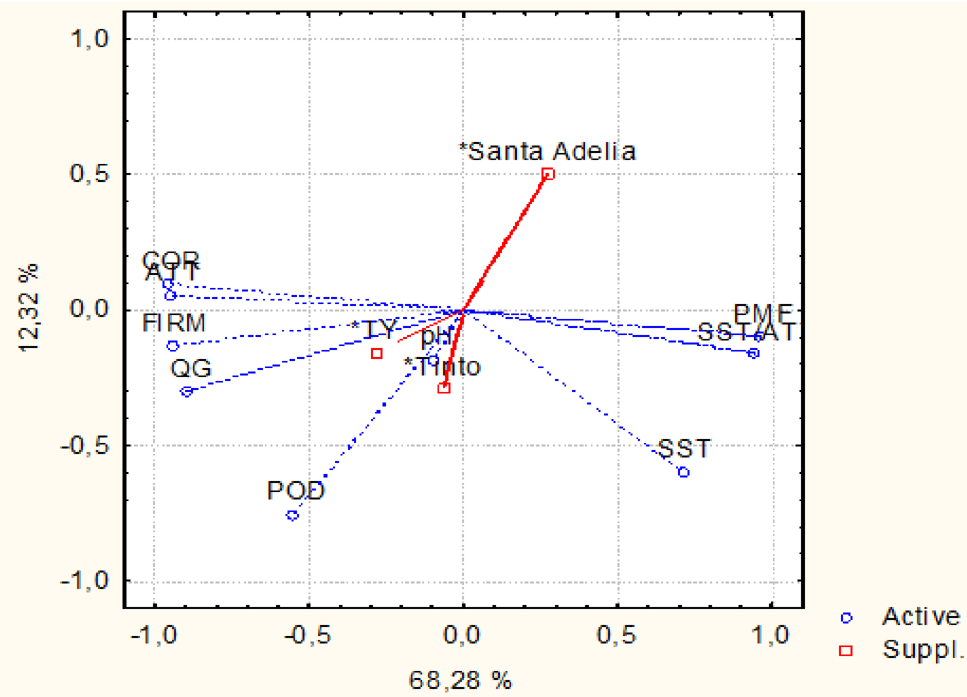

Figure 7. Principal component analysis (PCA) in table tomato cultivars over 12 days storage at room temperature (25 ± 2 ° C and 85 ± 5% U.R).

The variables loss of fresh mass, ratio (TSS/ATT), peel color, titratable total acidity and texture presented similar contributions for the ACP 1, this because they present vectors with greater length and that were closer to the CP1 axis (Figure 7).

There are high correlations between the loss of fresh mass, ratio (TSS/ATT), titratable total acidity, texture, shell color, general quality and pH, since acute angles are observed between these variables, due to the maturation process of the fruits presenting high transpiration rate (loss of fresh mass) favoring the loss of firmness and greater degradation of chlorophyll through changes in the color of the peel with reflections on the general quality of the fruits. The ripening also promotes a balance between sugars and organic acids (titratable total acidity) that characterize the fruit flavor called the TSS/ATT ratio (Figure 5).

For the variables incidence of rot and total soluble solids it is observed that there was no direct correlation with the other variables since the angle formed between the vectors is close to 90 °, however the length of the vectors of both variables indicates its relation with the ripening of the fruits is due to the fact that sugars tend to accumulate in the pulp as the maturation progresses until they are used in the respiratory metabolism already close to senescence where the first signs of rot are perceived (Figure 6D).

Also according to Figure 7, it can be inferred that the variables shell color, titratable total acidity, firmness and general quality are more associated to TY cultivar and that the loss of fresh mass and the ratio (TSS/ATT) with the cultivar Red. The pH is presented as an intermediate variable between the two cultivars. The cultivar Santa Adélia, on the other hand, did not present any characteristic variable. This fact is due to the low post-harvest useful life of its fruits that are soon compromised with the ripening.

Conclusions

The evaluated cultivars present significant differences regarding the physical-chemical and sensorial components that determine the quality during the storage.

The cultivar Santa Adélia was the one that exhibited the greatest physiological changes dur ing the storage indicating that this cultivar presents susceptibility after the harvest suggesting its commercialization and consumption in a short period.

The cultivar TY is the most suitable for commercialization and consumption in the region of study since it presents a greater resistance to the physical-chemical and sensorial changes induced by the maturation, that favor the post-harvest quality of the fruits of tomatoes, when stored in condition of room temperature. Principal component analysis ratifies this effect by correlating a larger number of variables to TY cultivar.

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