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Scientific paper

Action of vegetal regulators, environmental control and storage over parameters of sweet pepper conservation in postharvest

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Abstract

This work aimed to study the effect of plant growth regulators on postharvest by checking the conservation of the peppers hybrid Elisa stored under environmental control and refrigeration. The fruits were cooled in water for about five minutes and proceeding then to drying natural shade. The postharvest treatments were established: 1) control (water immersion), 2) 11.12 ml 4 L^{-1} of CK + GA (Gibberellic acid + cytokinin) 3)19 ml 4 L^{-1} of GA_{4+7} (gibberellic acid), 4) 1g L^{-1} GA_3, 5) 16.7ml 3 L of CK (cytokinin). The hormone treatments were diluted in 100 mg L^{-1}. Then the fruits were stored under normal environmental conditions and in cold chamber at a temperature of 8 ° C and 85-90% RH. The statistical design adopted was randomized blocks with five treatments and four replications. The experiment was evaluated from zero to 28 days every four days, through the following variables: color, fruit firmness, soluble solids, "Brix" (TSS), titratable acidity (TTA), TSS / TTA and carbohydrate soluble (WSCs). After 28 days of storage, it was found that the application of plant growth regulators had an influence on conservation in both environments. The fruits treated with GA_3 were more effective in maintaining levels of carbohydrate and soluble solids of fruits refrigerated.

Keywords: *Capsicum annuum L.*, Gibberellic acid, postharvest conservation.

Introduction

Pepper *Capsicum annuum* L. (Solanaceae) is a vegetable of great socioeconomic importance in Brazil, and it is spread mainly in the Southeast and Mid-west regions (COSTA et al., 2009; BÜTTOW et al., 2010). Fruits are consumed in great part in natura, either in the immature (green) or mature (mainly red and yellow) form. They are source of natural antioxidants as vitamin B, vitamin C and carotenoids and, they are also used in the food industry due to the presence of natural pigments in the pulp, which are used in food coloring (REIFSCHNEIDER, 2000; ARAÚJO NETO, 2009).

Vegetables are very perishable and continue the respiratory metabolism even after the harvest, and thus they present very short postharvest period of conservation, mainly in conditions of storage under high temperature and low relative humidity, which accelerate the loss of water, undervaluing the commercial value of fruits for the consumption in natura (MOTA et al., 2010).

Among the main problems related to the conservation of vegetables and fruits in this process it is noteworthy the changes in pigmentation, taste, firmness (BRACKMANN et al., 2007; ALVES et al., 2010), increase in the content of soluble soils, decrease in the free acidity (LEMOS et al., 2007; ALVES et al., 2010; STEFFENS et al., 2011), changes in the total soluble sugar (LIMA et al., 2004) and loss of fresh matter (SILVA et., 1999; MOTA et al., 2010), which are physical-chemical characteristics highly influenced by the temperature to which the fruits are exposed. Facing this, postharvest techniques which

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enable reduction of its metabolic activity deserve emphasis, since they represent an option for the increase of its shelf life.

Refrigeration is one of the main methods used in the conservation and storage of fruits and vegetables. The refrigerated storage consists in the reduction of the temperature and in the control of the relative humidity, which reduced the cell metabolism, delaying the fast deterioration (BRACKMANN et al., 2007).

In study performed in pepper it was verified that its ideal refrigeration is in the temperature of 10°C established as limit for the useful life, for until 20 days of storage, while in room temperature the useful life was only 8 days (LEMOS et al., 2007). Studies performed in tomato (BRACKMANN et al., 2007), okra (MOTA et al., 2010) and plums (ALVES et al., 2010) stored in the temperature close to 10°C present less occurrence of rot and higher efficiency in the control of the loss of the fruit fresh matter, according to the authors the reduction of the temperature constituted the main factor which influenced the maintenance of the fruit quality during the storage.

According to CARVALHO and MANICA (1994), the refrigerated storage extends the period of commerce of the fresh fruit, however it does not avoid physical-chemical changes, which depreciate its quality. Facing this, some techniques are commonly associated to refrigeration, as the application of vegetal regulators (SILVA et., 1999; STEFFENS et al., 2011). According to CHITARRA and CHITARRA (1990), the vegetal regulators ethylene and abscisic acid are seen as promoters of fruit maturation, while gibberellins, auxins and cytokinines as inhibitors in its maturation.

The use of vegetal regulators for an increase of the fruit quality has been studied, considering that gibberellins are more used and GA3 is its smallest representative (MODESTO et al., 2006; ALMEIDA et al., 2008; STEFFENS et al., 2011). In study of postharvest conservation, it is reported that GA3 maintained higher firmness of plum fruit pulp after the refrigerated storage (STEFFENS et al., 2011). Evidenced in kaki (FERRI et al., 2004), in tangerine Poncã (MODESTO et al., 2006) and in bitter orange ALMEIDA et al., 2008), delaying the (maturation and reducing rot in the storage.

Another growth regulator which has showed effect over the control of maturation and fruit ripening is cytokinines. SILVA et al. (1999), when studying pots-harvest of passion fruit, reported that when they were maintained under refrigeration, it was more efficient when it was used together with cytokinines, and it was more efficient in the maintenance of levels of vitamin C and soluble solids of fruits.

The installation of new researches about the physiology and biochemical of the postharvest are of major importance, since they may present positive or negative effects over the postharvest quality and fruit and vegetable shelf life (WORKNEH and OSTHOFF, 2010), being thus needed for the improvement of its commerce in the market. Works about the physical-chemical quality of pepper with interaction of controlled environment and vegetal regulators are scarce, and, facing this, the development of storage and postharvest management techniques is of major importance, as well as the evaluation of the effect of management practices over the quality and longevity during the process of commerce.

The objective of the work was to study the effect of the postharvest application of vegetal regulators in the conservation of pepper stored under environmental control and refrigeration.

Material and Methods

The experiment was conducted in the department of horticulture of the Faculty of Agronomic Sciences - UNESP - Campus of Botucatu. It was used as object of study pepper (*Capsicum annuum* L.), hybrid Elisa, which presents epidermis with reddish color when mature.

It was selected 300 fruits of size ranging from 80 and 120g. The main criterion for the selection of fruits was the degree of maturation, evaluated through the factor epidermal color. For this, it was used a visual scale which ranges between 0 and 100%, designating fruits totally green and totally red, respectively. The fruits selected for the experiment were those which presented the color of the epidermis with 60% in the day of the harvest.

After being harvested and selected, the fruits were cooled in water for five minutes and they were left to dry naturally in shadow.

In these conditions, fruits were submitted to application of treatments with hormones which consisted in the immersion of 60 fruits in solution in the concentration of 100 mg L^{-1} (Table 1). The immersion lasted 10 minutes. The fruits of the control group were immersed only in water.

The treatments consisted in the application of the regulators named above and in the storage of fruits in normal environmental conditions and cool chamber at the temperature of 8 °C and 85-90% RH. Thus, the treatments used were divided in two environments, 1st environmental conditions: **T1** (control), **T2** (GA+CK), **T3**(GA_{4+7}), **T4**(GA_3), T5(CK) and 2nd refrigerated: **T6**(control), **T7**(GA+CK), **T8**(GA_{4+7}), **T9**(GA_3), **T10**(CK).

For the monitoring of the evolution of the fruit maturation, it was determined in the experiment installation, and every four days ending at 28 days of storage (d.s.), color, fruit firmness, total soluble soils "Brix" (TSS), total titratable acidity (TTA), relation TSS/TTA and soluble carbohydrates (CHOs).

The fruit firmness was determined with aid of one penetrometer, it was measures in four points of the center region of the entire fruits, with results expressed in kilograms-force (kgf).

Table 1. Treatments with vegetable regulators in solution containing the concentration of 100 mg L^{-1}

Hormone		**Dilution /** 100 mg L^{-1}
Control	**-**	**-**
Gibberellic acid + Cytokinine	GA + CK	11.12 ml 4 L^{-1} .
Gibberellic acid	GA_{4+7}	19.04 ml 4 L^{-1}
Gibberellic acid	GA_3	5g 5 L^{-1}
Cytokinine	CK	16.68 ml 3 L^{-1}

The total soluble soils (TSS) were determined by refractometry, with the results expressed in Brix, according to the methodology TRESSLER and JOSLYN (1961).

The total titratable acidity (TTA) was determined by the milling with part of the pure juice diluted with 50 ml of distilled water, with solution of NaOH at 0.1N, standardized according to the technique recommended by the Instituto Adolfo Lutz (1985) and the results were expressed in grams of citric acid/100g of pulp and it was calculated the ratio TSS/ATT by the quotient between the two constituents.

For the determination of soluble carbohydrates (CHOs), it was made the clarification of the juice, it was used 10 g of sample diluted in 100 ml of distilled water and clarifying with 10 ml of potassium ferrocyanide 0.25 M and 9 ml of zinc acetate 1 M. It was taken 1 ml of clarified sample plus 1 ml of distilled water, which was added in test tube and its volume was completed to 100 ml with distilled water, forming the extract. Next, it was performed the determination of the content of soluble carbohydrate by the method described by DUBOIS et al. (1956), in test tubes containing 1 mL of extract, it was added 1ml of phenol solution and more 5 ml of concentrated sulfuric acid (H_2SO_4), with a total volume of 7 mL. Carbohydrates were counted from readouts of absorbance in 490 mm, using as pattern the D(+) glucose.

The statistic design used was the random blocks with 5 treatments and 4 replications. It was performed analysis of variance and procedure of mean comparison by T test at the level at 5% of probability.

Results and discussion

Color

For the variable fruit color, it was verified that treatments with the application of GA3, GA_{4+7} and CK did not differ from each other in the two types of storage (Figure 1A and 1B).

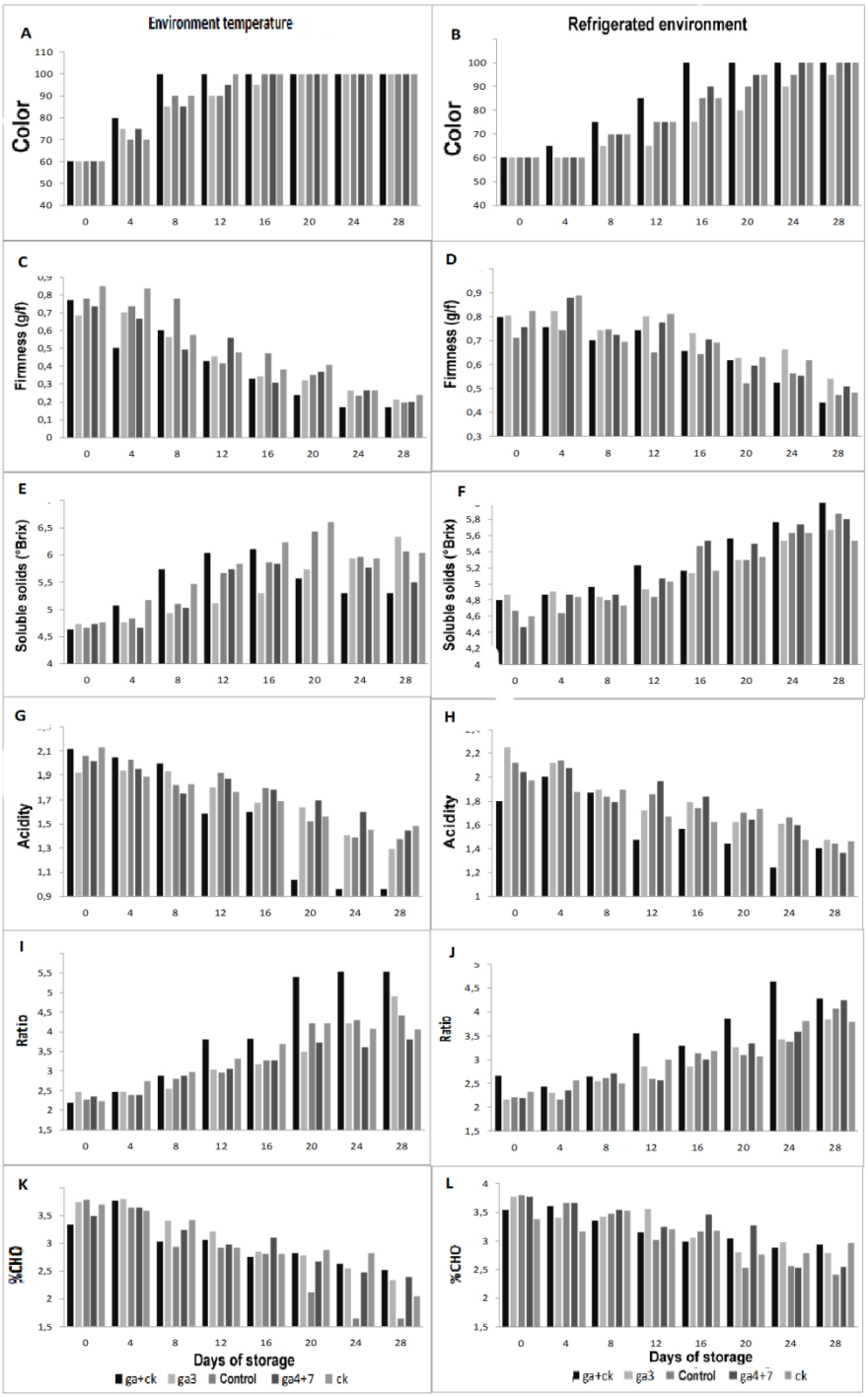

Figure 1. Results of Color (A, B), Firmness (C,D), Brix (SS°) (E, F), titratable acidity (G, H), Ratio (SS/TA) (I, J) and Carbohydrates under the treatments of Control, GA+CK, GA_3, GA_{4+7} and CK for room temperature and refrigerated environment along 28 days of storage.

However, the fruits of the control treatment presented accelerated increase of color from four days of storage (d.s.) and reached 100% of red color in the pellicle 16 d.s. For fruits treated with GA+CK the rate of increase of color was less accelerated, and in the 28 d.s. it was still observed fruits with part of the pellicle presenting greenish color.

Considering this characteristic, it can be emphasized a positive action of the treatment of fruits with GA+CK in the conservation of pepper in postharvest. This characteristic is more expressive when it is associated with the results of this treatment with the less accelerated increase in the content of total soluble soils.

In kaki, plum and peach it was also observed delay in the evolution of the color of the epidermis as a response to the application of Ga_3 (FERRI et al., 2004; AMARANTE et al., 2005; STEFFENS et al., 2010). WILLS et al. (1998) emphasize that the changes in color may be dependent on ethylene. Thus, treatments which affect the metabolism of this vegetal regulator may have different responses concerning the changes in color during ripening.

The visual aspect and the possibility of comer were higher in conditions of refrigeration, in which fruits were maintained fresh and bright with the maintaining of the color for a longer period of storage. These results are in accordance with the previous researches which show significant improvement in the storage of *Capsicum spp.*, found by SAMIRA et al. (2011). The same authors report the act of refrigeration helping in the disinfection and in the atmospheric modification during the period of storage.

Firmness

The fruit firmness started to decrease from eight days of storage in both environments (Figure 1C and 1D), with emphasis in the treatment GA+CK which maintained higher averages during all the period of storage, at 28 days obtained average of 0.59 kgf under refrigeration standing out in relation to the other treatments (Table 2).

In the storage under room temperature, it was not observed efficiency of the treatments in this requirement, evidencing that GA+CK under refrigeration maintained fruits firmer for a longer period of time.

Table 2. Mean values of Firmness in pepper Elisa under treatments of GA+CK. GA_3. GA_{4+7}. CK and control stored in condition of room temperature and refrigerated environment for 28 days

	Day of storage							
Firmness	**0**	**4**	**8**	**12**	**16**	**20**	**24**	**28**
				Room temperature				
Control	A0.84a	0.59Ca	0.66Ba	0.44Da	0.34Ea	0.20Fa	0.15Ga	0.15Ga
GA+CK	B0.77a	0.81Aa	0.56Ca	0.46Ca	0.38Da	0.29Ea	0.23Ea	0.21 Ea
GA_{4+7}	A0.72a	0.62Aa	0.44Ba	0.45Ba	0.38Ba	0.39Ba	0.32Ba	0.18Ca
GA_3	A0.85a	0.80Aa	0.83Aa	0.50Ba	0.49Ba	0.32Ca	0.22Ca	0.17Ca
CK	A0.91a	0.81Ba	0.52Ca	0.50Da	0.37Ea	0.34Ea	0.28Ea	0.21Ea
CV (%)	53.7							
				Refrigerated environment				
Control	0.80aA	0.75aA	0.70aB	0.74aB	0.65aB	0.62aC	0.52aD	0.40aE
GA+CK	0.80aA	0.82aA	0.65aA	0.80a A	0.73aA	0.66aA	0.66aA	0.59aA
GA_{4+7}	0.75aB	0.87aA	0.72aC	0.77aB	0.70aC	0.59aD	0.55aD	0.51aE
GA_3	0.71aA	0.74aA	0.74aA	0.65aB	0.64aB	0.55aB	0.56aB	0.47aC
CK	0.82aB	0.88aA	0.69aC	0.81aB	0.69aC	0.63aD	0.65aD	0.48aE
CV (%)	20							

Averages followed by different uppercase letters and lowercase in column differ from each other by Tukey test $P > 0,05$.

According to LEMOS et al. (2007), it is expected over the period of storage that the firmness of the pepper fruits reduces markedly due to the processes of ripening, since due to the loss of turgidity, related to the loss of water and to the senescence of pepper fruits, the tissues of the fruits offer lower resistance to rupture. Therefore, with the refrigeration and the treatment of GA+CK, the process of senescence was reduced, improving the physical characteristic of the fruit.

Studies in normal environmental conditions showed that the GA_3 acted delaying the maturation in kaki in approximately 20 days, delaying the reduction of the pulp firmness (FERRI et al., 2004). In studies of the effect of GA_3 and one inhibitor of ethylene in the storage of plump (STEFFENS et al., 2011) and in peaches (AMARANTE et al., 2005) under refrigeration, the authors found higher values of penetration, pulp firmness and fruit compression with this treatment. This response is directly related to the effect over the reduction in the synthesis of ethylene (AMARANTE et al., 2005).

ºBrix

The content of soluble solids (Brix) ranged significantly (*P<=0,05*) between treatments (Table 3). Fruits which belong to the control reached 6,1ºBrix at 16 days of storage and decreased to 5,3ºBrix at 28 days in room conditions (Figure 1E and 1F), however under refrigeration this value increased reaching 6ºBrix at 28 days of storage. This indicated that refrigerated environment helped in the conversion of starch in sugar, however the rate in which the levels of SS increase was higher in the room temperature than under refrigeration and the decrease of SS by the control reports that the fruit cells used sugar in the respiration (SAMIRA et al., 2011). It is known that sugars and simple acids are substrates of the respiration, and the longer the fruits cell respire, the higher will be the rate of consumption of this substrate (ATTA-ALY and BRECHT, 1995).

Table 3. Mean values of Brix in Elisa peppers under treatments of GA+CK, GA_3, GA_{4+7}, CK and control stored in conditions of room temperature and refrigerated environment for 28 days.

	Day of storage							
ºBrix	**0**	**4**	**8**	**12**	**16**	**20**	**24**	**28**
				Room temperature				
Control	4.6aE	5.0aD	5.7aB	6.0aA	6.1aA	5.5cC	5.3aC	5.3cC
GA+CK	4.7aG	4.7aG	4.9aF	5.4aD	5.3aE	5.7bC	5.9aB	6.3aA
GA_{4+7}	4.7aE	4.6aE	5.0aD	5.7aB	5.8aB	6.3bA	5.7aB	5.5bC
GA_3	4.6aF	4.8aE	5.1aD	5.6aC	5.8aB	6.4bA	5.9aB	6.0bA
CK	4.7aF	5.1aE	5.4aD	5.8aC	6.2aB	6.6aA	5.9aC	6.0bC
CV (%)	10.6							
				Refrigerated environment				
Control	4.8aA	4.8aA	4.9aA	5.2aA	5.1aA	5.5aA	5.7aA	6.0aA
GA+CK	4.8aA	4.9aA	4.8aA	4.9aA	5.1aA	5.3aA	5.5aA	5.6aA
GA_{4+7}	4.4aC	4.8aB	4.8aB	5.0aB	5.5aB	5.5aB	5.7aA	5.8aA
GA_3	4.6aA	4.6aA	4.8aA	4.8aA	5.4aA	5.3aA	5.6aA	5.8aA
CK	4.6aA	4.8aA	4.7aA	5.0aA	5.1aA	5.3aA	5.6aA	5.5aA
CV (%)	9.2							

Averages followed by different uppercase letters and lowercase in column differ from each other by Tukey test P > 0,05.

The higher content of soluble soils was found in the treatment of cytokinin (CK) at 20 days of storage and by the mixture of gibberellins with cytokinin (GA+CK) at 28 days both in room conditions reaching 6.6 and 6.3°Brix respectively (Table 3). Gibberellins and cytokinins delay the senescence, reducing the production of ethylene and the rate of respiration, which reflects a longer period of storage (PAYASI e SANWAL, 2008).

STEFFENS et al. (2009), studying vegetal regulators in plum, verified that the gibberellic acid (GA_3) caused the reduction of the values of soluble soils, and the evolution of the maturation was delayed in room temperature.

In study of passion fruit, it was verified that cytokinin was more efficient in the maintenance of the soluble soils in refrigerated environment (SILVA et al., 1999).

Acidity

Under conditions of room temperature and refrigerated environment, there was a decrease of the value of acidity observed in Figure 1G and 1H. The treatment of GA+CK presented the lower acidity at 28 days of storage under room temperature and did not differ statistically from treatment Ga_{4+7} (Table 4). However, under refrigerated room, the lower average at 28 days was in the treatment GA_{4+7} and GA_3.

FERRI et al. (2004) in his work was observed a linear decrease that is referent to the total titratable acidity (TTA) for the kaki fruits treated with AG_3 and STEFFENS et al. (2009) in plum, contributing to the delay of the maturation.

The reduction of the acidity, characteristic of the fruit ripening due to the reduction of the organic acids, is also resulting of the stress caused by the harvest and during the storage, due to the oxidation of these compounds in the production of energy trough Krebs cycle to maintain the vital processes (FENNEMA, 2000).

Table 4. Mean values of Acidity in Elisa peppers under treatment of GA+CK, GA_3, GA_{4+7}, CK and control stored in conditions of room temperature and refrigerated environment for 28 days.

	Day of storage							
Acidity	**0**	**4**	**8**	**12**	**16**	**20**	**24**	**28**
	Room temperature							
Control	2.1aA	2.0aA	1.9aA	1.5aB	1.5aB	1.0aC	0.9aC	0
GA+CK	1.9aA	1.9aA	1.9aA	1.8aA	1.6aA	1.6aA	1.4aA	1.2aA
GA_{4+7}	2.0aA	1.9aA	1.7aA	1.8aA	1.7aA	1.6aA	1.5aA	1.4aA
GA_3	2.0aA	2.0aB	1.8aB	1.9aB	1.7aB	1.5aB	1.3aB	1.3aC
CK	2.1aA	1.9aB	1.8aB	1.7aB	1.6aB	1.5aB	1.4aC	1.4aB
CV (%)	24.9							
	Refrigerated environment							
Control	1.8aB	2.0aA	1.8aB	1.4aD	1.5aC	1.4aD	1.2aE	1.4aD
GA+CK	2.2aA	2.1aB	1.8aC	1.7aC	1.7aC	1.6aD	1.6aD	1.4aE
GA_{4+7}	2.0aA	2.0aA	1.7aB	1.9aA	1.8aB	1.6aB	1.5aB	1.3aC
GA_3	2.1aA	2.1aA	1.8aB	1.8aB	1.7aB	1.7aB	1.6aB	1.4aC
CK	1.9aA	1.8aA	1.9aA	1.6aA	1.6aA	1.7aA	1.4aA	1.4aA
CV (%)	18.7							

Averages followed by different uppercase letters and lowercase in column differ from each other by Tukey test P > 0,05.

Ratio: SST/ATT

It can be verified that under room temperature, along the 28 days, the lower averages were found in treatment GA_{4+7}, becoming equal to the other treatments in the final stage of the storage (Table 5). Under refrigeration, the control presented one high relation 24 d.s., however at 28 d.s. this value decreased, evidencing that there was reserve consumption (Figure 1J).

The ratio between the content of soluble soils and the acidity brings one form to evaluate the taste: higher values to these characteristics are associated to a more pleasant taste (CHITARRA and CHITARRA 1990). The use of GA3 in bitter orange was efficient in the reduction of the TSS/ATT ratio, prolonging the period of harvest without changing the fruit quality (ALEMIDA et al., 2008).

Study performed by GÓMEZ and CAMELO (2002), evaluating the postharvest quality of tomato stored under refrigeration for 36 days, evidenced an increase in the TSS/TTA relation in the beginning of the experiment due to a significant drop in the acidity and a light increase in the content of soluble soils. This proportion dropped in a continuous way until the end of the storage.

In pepper stored for twenty days in room conditions, green fruits presented higher values for the relation TSS/TTA (3.23) than the most mature (2.37), since the acidity in green pepper was lower (DAMATTO JUNIOR et ., 2010).

Table 5. Mean values of ratio in Elisa peppers under treatments of GA+CK, GA_3, GA_{4+7}, CK and control stored in room temperature and refrigerated environment conditions for 28 days.

	Day of storage							
Ratio	**0**	**4**	**8**	**12**	**16**	**20**	**24**	**28**
				Room temperature				
Control	2.2aD	2.4aC	2.9aC	3.8aB	3.8aB	5.5aA	5.5aA	0
GA+CK	2.4aE	2.4aE	2.5aE	3.0aD	3.1aD	3.5cC	4.2bB	4.9aA
GA_{4+7}	2.3aC	2.4aB	2.8aB	3.0aB	3.2aB	3.7cB	3.6cB	3.8aA
GA_3	2.3aG	2.4aG	2.8aF	2.9aE	3.3aD	4.2bC	4.4bB	4.5aA
CK	2.2aC	2.7aB	3.0aB	3.3aB	3.7aB	4.2bA	4.1bA	4.1aA
CV(%)	27.8							
				Refrigerated environment				
Control	2.8aF	2.4aG	2.6aF	3.5aD	3.3aE	3.9aC	4.7aA	4.3aB
GA+CK	2.1aC	2.3aC	2.5aB	2.8aB	2.9aB	3.3aB	3.4bB	3.8aA
GA_{4+7}	2.2aE	2.3aD	2.7aD	2.6aD	3.0aC	3.3aC	3.6bB	4.3aA
GA_3	2.2aC	2.1aC	2.6aC	2.6aC	3.2aB	3.1aB	3.3cB	4.0aA
CK	2.3aC	2.5aB	2.5aB	3.0aB	3.2aB	3.0aB	3.8bA	3.8aA
CV(%)	26.9							

Averages followed by different uppercase letters and lowercase in column differ from each other by Tukey test P > 0,05.

Carbohydrate

The analysis of variance showed significant difference for the characteristic CHO, decreasing over the period of storage (Figure 1K and 1L). The treatments GA+CK and GA_{4+7} in room temperature presented the Best averages over the entire period (Table 6). The analysis of variance between the periods of storage showed that the treatments under refrigeration present lower reduction of CHO, with emphasis in the treatments of the vegetal regulators GA+CK and CK which maintained the best averages during all the period of storage with final averages of 2.9%. These results indicate that for the fruit maturation it occurs the conversion of starch in sugar, increasing the content of soluble soils of fruits caused by the decomposition of carbohydrates.

GOMES et al. (2002) report that soluble sugar present in fruits in the combined form are responsible for sweetness, taste and attractive color as derived from anthocyanin's and by the texture, when combined appropriately structural polysaccharides.

Table 6. Mean values of Carbohydrate in Elisa pepper under treatments of GA+CK, GA_3, GA_{4+7}, CK and control stored in room conditions and environment refrigerated for 28 days.

	Day of storage							
CHO (A)	**0**	**4**	**8**	**12**	**16**	**20**	**24**	**28**
	Room temperature							
Control	3.7aA	3.6aA	2.9aB	2.9aC	2.8aC	2.1aE	1.6aG	0
GA+CK	3.3aA	3.7aA	3.0aA	3.0aA	2.7aA	2.8aA	2.62aA	2.5aA
GA_{4+7}	3.4aA	3.6aA	3.2aA	2.9aA	3.1aA	2.6aA	2.4aA	2.3aA
GA_3	3.7aA	3.7aA	3.4aB	3.2aB	2.8aB	2.7aB	2.5aB	2.3aC
CK	3.7aA	3.5aA	3.4aA	2.9aB	2.8aB	2.8aB	2.8aB	2.0aC
CV(%)	27.1							
	Refrigerated environment							
Control	3.7aA	3.6aA	3.4aA	3.0aB	3.1aB	2.5aC	2.5aC	2.4aC
GA+CK	3.5aA	3.6aA	3.3aA	3.1aA	2.9aA	3.0aA	2.8aA	2.9aA
GA_{4+7}	3.7aA	3.6aA	3.5aA	3.2aB	3.4aA	3.2aB	2.5aC	2.5aC
GA_3	3.7aA	3.4aB	3.4aB	3.5aB	3.0aB	2.7aB	2.9aC	2.7aC
CK	3.3aA	3.1aA	3.5aA	3.2aA	3.1aA	2.7aA	2.7aA	2.9aA
CV(%)	15.9							

Averages followed by different uppercase letters and lowercase in column differ from each other by Tukey test P > 0,05.

Conclusions

The vegetal hormones GA_3 (1g L^{-1}) and GA_{4+7} (19,04 ml 4 L^{-1}) were efficient in delaying the postharvest metabolism of the pepper fruits stored in room and conditioned conditions, as well as in promoting barrier against postharvest losses of pepper fruit.

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