Quality changes of acerola fruit harvested at different maturity stages and exposed to external ethylene[1]

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ABSTRACT

Although acerola (*Malpighia emarginata* D.C.) has been suggested to be a climacteric fruit, little is known about its sensitivity to exogenous ethylene. The objective of the study was to evaluate the quality changes of acerola fruit at two harvest maturity stages in response to external ethylene application. 'Flor Branca' and 'Junko' acerolas were harvested at the maturity stages 1 (green fruit with density>1 g cm^{-3}) and 2 (green fruit with density <1 g cm^{-3}) and were treated with 0 or 1,000 µL L^{-1} of ethylene for 24 hours at 12 ºC.The fruit were stored at 12ºC with relative humidity of 90-95% for 14 days. Both cultivars harvested at the maturity stage 2 showed skin color change from green to red during storage, which was not observed in fruit harvested at the maturity stage 1. External ethylene had no effect on 'Flor Branca' and 'Junko' acerolas respiration rate, flesh firmness, skin color, weight loss, soluble solids (SS), titratable acidity (AT), SS/AT ratio, and ascorbic acid contents. The classification of green acerolas by density was an effective approach to determine fruit harvest maturity for fresh consumption.

Keywords: *Malpighia emarginata* D.C.; respiration rate; flesh firmness; skin color; ripening.

INTRODUCTION

Acerola (*Malpighia emarginata* D.C.) is a tropical fruit with high levels of ascorbic acid and short postharvest life (Alves *et al.*, 1995). Although a few studies have suggested that acerola is a climacteric fruit, limited information is available about fruit physiology during ripening (Alves *et al.*, 1995; Carrington & King, 2002).

Climacteric fruit are characterized by a rapid and marked increase in respiration rate and autocatalytic ethylene synthesis during ripening, whereas non-climacteric fruit have no increase in respiration rate and are much less sensitive to external ethylene due to the lack of autocatalytic ethylene synthesis during ripening (Barry & Giovannoni, 2007; Chen *et al.*, 2020).

Although the increase in respiration has been used to classify fruit as climacteric or non-climacteric, different species can have a wide range of respiration rates and complex metabolic processes during ripening (Azzolini *et al.*, 2005; Wills & Golding, 2016; Chen *et al.*, 2020). In that case, ethylene can be used to help characterizing the ripening metabolism (Archbold & Pomper, 2003). In climacteric fruit, external ethylene triggers its autocatalytic synthesis, anticipates the increase in respiration and accelerates quality changes, whereas in non-climacteric fruit, external ethylene leads to an imminent increase followed by a decrease in respiratory activity and has limited effect on quality changes (Abeles *et al.*, 1992; Silva *et al.*, 2009; Silva *et al.*, 2012).Therefore, due to the lack of autocatalytic ethylene synthesis, non-climacteric fruit increase respiration rate and metabolic activity only during the exposure

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to the hormone, decreasing thereafter (Abdi *et al.*, 1998; Araújo *et al.*, 2017).

Fruit maturity plays an important role on ethylene responses (Lelièvre *et al.*, 1997; Silva *et al.*, 2012). Climacteric fruit at early stages of development, before the physiological maturity, present a non-climacteric behavior in response to exogenous ethylene, as the fruit have not yet developed the mechanisms for perception and response to this hormone (Nham *et al*., 2015). Non-climacteric fruit at early stages of development also have low responses to ethylene (Fox *et al.*, 2005; Chen *et al.*, 2017).

Although a few studies have suggested that acerola has a climacteric behavior, more information is required to better understand fruit ripening metabolism in response to exogenous ethylene. The objective of the study was to evaluate the quality changes of acerola fruit at two harvest maturity stages in response to external ethylene application.

MATERIAL AND METHODS

'Flor Branca' and 'Junko' acerola plants with 7 and 3 years old, respectively, were cultivated at 4.0 x 5.0 m spacing and were irrigated with micro sprinkler in a commercial orchard located in Petrolina, PE, Brazil, region known as the São Francisco Valley, (09° 09'S and 40° 22' W). The region has a Semi-arid climate (Bswh, according to Koppen) with average altitude of 365.5 m, annual temperature of 26°C, rainfall of 500 mm, and relative humidity of 66%. Crop management practices followed the recommendations for the region (Embrapa, 2012). These cultivars were chosen because 'Flor Branca' and 'Junko' acerola fruit have shorter and longer postharvest life, respectively. After full growth, green colored fruit (skin hue angle > 100º) were harvested and then classified in two maturity stages based on density, where maturity 1 = green fruit with density >1 g cm^{-3}, and maturity 2 = green fruit with density <1 g cm^{-3}. This approach was used because precedent studies have indicated that acerola fruit with density >1 g cm^{-3} do not change skin color, whereas fruit with density <1 g cm^{-3} do change color after harvest (Ribeiro & Freitas, 2020). Acerola fruit were harvested early in the morning and taken to the Postharvest Laboratory at the Brazilian Agricultural Research Corporation, Embrapa, Petrolina, PE, Brazil. Fruit presenting mechanical damage, defects and incidence of diseases and insects were eliminated. Acerolas were separated at each maturity stage by immersing the fruit of each cultivar in water (density of 1 g cm^{-3}). Later, the fruit were washed with chlorinated water, containing 600µL L^{-1} of free chlorine, and were dried at 20 °C.The washed fruit were then randomized to compose the experimental samples. In each acerola cultivar, fruit of the two maturity stages were treated with 0 or 1,000 µL L^{-1} of ethylene (99.98%) (White Martins, Salvador, BA, Brazil), which was accomplished in airtight pots of 1L for 24 hours at 12 ºC ± 0.5 ºC. After ethylene treatment, fruit were stored at 12 ºC ± 0.5 ºC with a relative humidity of 90-95%. The experiment followed a completely randomized design with two factors (maturity stage x ethylene treatment). Each treatment was composed by four repetitions and each replication by 250g of acerola packed in clamshell container with 5x10x17cm (height x width x length). Fruit were evaluated at harvest, after ethylene treatment, 7 and 14 days of storage, as described below.

Respiration rate was determined according to approach described by Castellanos & Herrera (2015). Acerola fruit were closed in 1L airtight pots for 1 hour at 12 °C. Then, the carbon dioxide (CO_2) concentration in each pot was measured with a gas analyzer model PA 7.0 (Witt, Alcochete, Portugal). The results were presented as mol of CO_2 kg^{-1} h^{-1}. In the same hermetically sealed sample used for respiration rate analysis, a 10 mL sample was taken and injected in a Thermo Scientific gas chromatograph model Trace 1310 (Themo Scientific, SP, Brazil), coupled with a flame ionization detector (FID) and a Porapak N80/100 column in order to analyze the ethylene production.

Skin color was observed in the equatorial region of each fruit with a Minolta colorimeter model CR-400 (Konica Minolta, Tokyo, Japan). The results were expressed as lightness L* that corresponds to the variations from dark (0) to white (100); chroma C^*_{ab} that represents the color saturation or intensity, which ranges from 0 = impure to 60 = pure, and Hue angle h_{ab} that represents the color change from blue (270º), green (180°) to yellow (90°) and red-purple (0°) (Mcguire, 1992).

Flesh firmness (FF) was determined as the maximum force required to compress 10% of the fruit diameter, using a texture analyzer model TA.XT.Plus (Extralab®, São Paulo, Brazil), which was equipped with a P/75 pressure plate. The results were expressed in Newton (N).

Weight loss (WL) was calculated by multiplying the difference between the initial and final weight of each sample by 100 and dividing by the initial sample weight. The results represent the percentage of total weight loss during storage.

All fruit without the seed in each replication were used

to obtain the juice, which was used to determine the soluble solids content (SS) by dripping 1mL of juice in a digital refractometer model PAL-1 (Atago, São Paulo, Brazil). The results were presented as percentage of SS content in the fruit juice.

Titratable acidity (TA) was determined in 1 mL of juice diluted in 50 mL of distilled water, which was titrated with a solution of 0.1 N NaOH until pH 8.1. Titration was accomplished with a 848 Titrino Plus automatic titrator (Metrohm, São Paulo, Brazil). The results were presented as percent of malic acid in the fruit juice. The SS/TA ratio was determined by dividing the SS content by the respective TA in each sample.

Ascorbic acid (AA) content was determined from the dilution of 0.5 mL of juice in 100 mL solution containing 0.5% of oxalic acid and titrated with a solution containing 0.02% of 2,6-dichlorophenolindophenol (DFI) until permanent light pink color observation (Strohecker & Henning, 1967). The results were presented as percentage of AA in the fruit juice.

The data were subjected to the analysis of variance. At harvest, the source of variation was the maturity stage, whereas at 7 and 14 days of storage, the sources of variation were the maturity stage and external ethylene concentration. Mean comparisons were accomplished by the Tukey's test ($P < 0.05$). Decay incidence and weight loss data were transformed by the $arcsen\sqrt{x}/100$ equation. The statistical analysis was carried out with the software ExpDes.pt and R version 3.2.5 (R Development Core Team, 2016).

RESULTS AND DISCUSSION

Respiration rate and ethylene synthesis

According to the results, maturity stage at harvest and external ethylene treatment had significant interaction for respiration rate of 'Flor Branca' and 'Junko' acerolas during storage at 12 °C. 'FlorBranca' and 'Junko' acerolas showed no respiration rate responses to external ethylene treatment at both maturity stages (Figure 1). External ethylene resulted in higher respiration rate only one day after treatment of 'Flor Branca' fruit at the maturity stage 2 (Figure 1). 'Flor Branca' and 'Junko' acerolas harvested at the maturity stage 2 had lower respiration rates than acerolas harvested at the maturity stage 1 at 7 and 14 days of storage, respectively (Figure 1).

Although gas samples were taken at each evaluation day for ethylene analysis, no ethylene was detected by gas chromatograph in all experimental samples, which had a detection limit of 10 $\mu L\ L^{-1}$. Cellular respiration is one of the most important processes responsible for the production of energy and intermediate compounds, required for normal cellular metabolism, which determines fruit quality (Saquet *et al.*, 2000; Wills & Golding, 2016). Previous studies have suggested that acerola has a climacteric behavior, increasing respiration rate during skin color changes from green to red (Alves *et al.*, 1995; Carrington & King, 2002). However, very low ethylene production has been observed in acerolas during skin color changes, compared to other climatic fruit (Carrington & King, 2002).

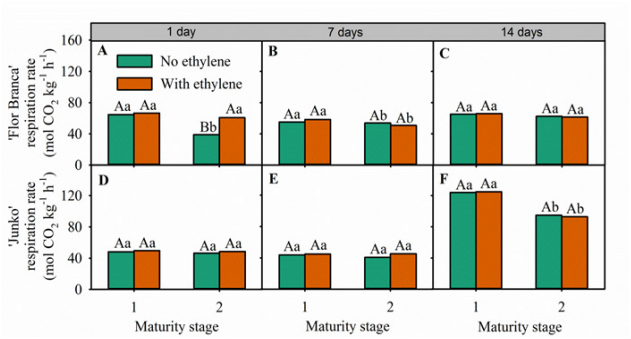

Figure 1: Respiration rate of 'Flor Branca' and 'Junko' acerolas harvested at two maturity stages and treated or not treated with ethylene. Capital letters compare ethylene concentrations, whereas lower case letters compare maturity stages at each evaluation day. Means followed by the same letters are statistically equal according to the Tukey's test (5%).

Fruit can have two ethylene production systems. System 1 is functional in vegetative tissues, as well as in non-climacteric fruit and at pre-climacteric stages of climacteric fruit, which is responsible for low ethylene production (Barry *et al.*, 2000; Nham *et al.*, 2015). System 2 is functional at the climacteric stage of climacteric fruit, which is responsible for the autocatalytic ethylene production during ripening, increasing fruit ethylene synthesis and respiration rates in response to exogenous ethylene (Symons *et al.*, 2012; Nham *et al.*, 2015). Therefore, in climacteric fruit, system 1 operates until the beginning of ripening, when then, exposure to the low concentrations of ethylene synthesized by system 1 promotes a great increase in ethylene synthesis due to appearance of system 2 in the fruit (Nham *et al.*, 2015). Studies have shown that exogenous ethylene responses are highly dependent on genotype, maturity stage and respiration pattern, as observed in climacteric fruit such as papaya (Façanha *et al.*, 2019) and mangoes (Lalel *et al.*, 2003). In these studies, when the

fruit were harvested at earlier maturity stages and treated with exogenous ethylene, there was a rapidly increase in ethylene production and respiration rate. In addition, strawberries, which are non-climacteric, exhibit high respiration rates after the exposure to exogenous ethylene (Elmi *et al.*, 2017). These studies suggest that exogenous ethylene can influence climacteric and non-climacteric fruit in different ways, possibly because there are ethylene dependent and independent metabolic pathways leading to ripening on each fruit species (Lelièvre *et al.*, 1997; Chen *et al.*, 2020). In our study, the results suggest that acerolas harvested at both maturity stages did not have the autocatalytic ethylene production system during ethylene treatment, which would have increased ethylene synthesis, respiration rate and accelerated ripening, compared to non-treated fruit, as it happens in climacteric fruit (Lelièvre *et al.*, 1997; Nham *et al.*, 2015; Chen *et al.*, 2020).

Skin color h_{ab}

According to the results, maturity stage at harvest and external ethylene treatment had significant interaction for skin h_{ab} of 'Flor Branca' and 'Junko' acerolas during storage at 12 °C. External ethylene treatment at harvest had no effect on 'Flor Branca' and 'Junko' acerola skin color during storage at 12 ºC (Figure 2). The only exception was for 'Flor Branca' acerola harvested at the maturity stage 2 and stored for 7 days at 12 ºC, which showed a small reduction in green color in response to ethylene (Figure 2). 'Flor Branca' acerolas harvested at the maturity stage 1 had greener (higher hab) skin color during storage than acerolas harvested at the maturity stage 2 (Figure 2). 'Junko' acerolas harvested at different maturity stages showed similar skin color hab at harvest (Figure 2). However, 'Junko' acerola harvested at the maturity stage 2 showed an increasing loss of green color (lower h_{ab}) after 7 and 14 days of storage, compared to acerolas harvested at the maturity stage 1 (Figure 2). Both acerola cultivars harvested at the maturity stage 2 showed red skin color at 14 days of storage, regardless external ethylene treatment at harvest (Figure 2).

Although acerola has been suggested to be a climacteric fruit (Alves *et al.,* 1995; Carrington & King, 2002), our results showed that skin color change during storage was independent on external ethylene treatment at harvest, which is the most important quality index used to determine acerola ripening stage (Ribeiro & Freitas, 2020).

The loss of green color is associated with chlorophyll breakdown due to the activity of chlorophyllases, as well as changes acidity and oxidative processes in the fruit. In climacteric fruit, ethylene increases chlorophyllase activity (Shemer *et al.*, 2008), as well as carotenoid synthesis that accelerates color changes from green to yellow, as observed in papaya and mango (Montalvo *et al.*, 2007; Façanha *et al.*, 2019). In non-climacteric fruit, ethylene can also play an important role on reducing green color by increasing chlorophyll degradation, as observed in citrus and pineapple (Goldschmidt, 1997; Paul *et al.*, 2012), as well as on triggering the synthesis of other pigments such as anthocyanins in strawberries (Villarreal *et al.*, 2010; Elmi *et al.*, 2017). Our results suggest that chlorophyll breakdown and synthesis of red/yellow pigments in acerola fruit were ethylene independent processes. Alternatively, acerola responses leading to chlorophyll breakdown and red/yellow pigment synthesis could be saturated by the low levels of internal ethylene (<10 µL L^{-1}) reported in other studies (Carrington & King, 2002). However, studies in our laboratory have shown no effect of ethylene inhibitors on acerola ripening (unpublished data), providing evidences that skin color changes were indeed an ethylene independent process in this fruit species.

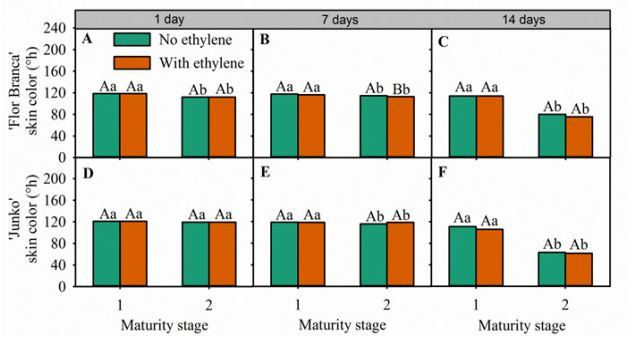

Figure 2: Skin color of 'Flor Branca' and 'Junko' acerolas harvested at two maturity stages and treated or not treated with ethylene. Capital letters compare ethylene concentrations, whereas lower case letters compare maturity stages at each evaluation day. Means followed by the same letters are statistically equal according to the Tukey's test (5%).

Flesh firmness

According to the results, maturity stage at harvest and external ethylene treatment had significant interaction for flesh firmness of 'Flor Branca' and 'Junko' acerolas during storage at 12 °C. During storage, flesh firmness of 'Flor Branca' acerolas was higher in fruit harvested at the maturity stage 1, compared to fruit harvested at the maturity stage 2 (Figure 3). At 7 and 14 days of storage, 'Flor Branca' acerolas harvested at the maturity stage 2 showed lower

flesh firmness in response to external ethylene treatment (Figure 3). Similar reduction on flesh firmness in response to external ethylene was observed in 'Flor Branca' acerolas harvested at the maturity stage 1 and stored for 14 days at 12 ºC (Figure 3). During storage of 'Junko' acerolas, there was no effect of maturity stage and external ethylene treatment on fruit flesh firmness (Figure 3).

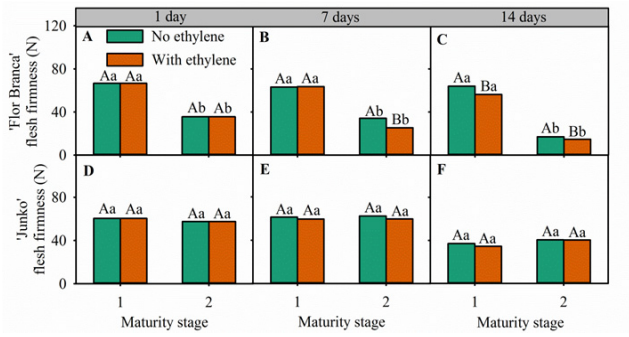

Figure 3: Flesh firmness of 'Flor Branca' and 'Junko' acerolas harvested at two maturity stages and treated or not treated with ethylene. Capital letters compare ethylene concentrations, whereas lower case letters compare maturity stages at each evaluation day. Means followed by the same letters are statistically equal according to the Tukey's test (5%).

Fruit flesh firmness is determined by the cell wall structure and strength, as well as by the cellular turgor pressure (Ponce *et al.*, 2010). During ripening, the increasing activity degrading enzymes leads to of this protective structure depolymerization and solubilization, which results lower flesh firmness (Silva *et al.*, 2009). In addition, ripening processes also leads to higher membrane leakage that results in lower cellular turgor pressure and flesh firmness. In 'Flor Branca' acerolas, the observed lower flesh firmness at the maturity stage 2, as well as in response to external ethylene suggest that fruit softening was a combination of ethylene independent and dependent processes, because both ethylene exposed and non-exposed fruit showed loss of flesh firmness, which was only enhanced by external ethylene. However, in 'Junko' acerolas, the observed loss of flesh firmness was independent of ethylene. Indeed, the loss of flesh firmness due to cell wall breakdown is accomplished by a wide range of cell wall degrading enzymes, some of which are dependent while others are independent of ethylene. The ethylene dependent and independent cell wall breakdown and loss of flesh firmness have been reported in many climacteric fruits such as papaya (Façanha *et al.*, 2019) and mango (Montalvo *et al.*, 2007), as well as in non-climacteric fruit such as strawberry (Villarreal *et al.*, 2009; Villarreal *et al.*, 2010; Merchante *et al.*, 2013; Villarreal *et al.*, 2016).

Maturity stage and physicochemical quality

According to the results, maturity stage at harvest and external ethylene treatment had no significant interaction for acerola color parameters L* and C^*_{ab}, weight loss, SS, AT, SS/TA, and AA, which were only influenced by the maturity stage at harvest (Tables 1 and 2). After one day of storage, 'Flor Branca' acerolas at the maturity stages 1 and 2 had similar skin L* and C^*_{ab} values (Table 1). However, 'Flor Branca' fruit had higher SS, SS/TA and AA levels and lower TA at the maturity stage 1, compared to fruit at the maturity stage 2 (Table 1). At 7 days of storage, 'Flor Branca' acerolas harvested at the maturity stage 2 had higher skin L* and C^*_{ab}, and TA, as well as lower weight loss, SS, SS/TA, and AA concentration, than acerolas harvested at the maturity stage 1 (Table 1). At 14 days of storage, 'Flor Branca' acerolas harvested at the maturity stage 1 had higher skin L*, weight loss, SS, SS/TA, and AA concentration, as well as lower TA, than acerolas harvested at the maturity stage 2 (Table 1).

After one day of storage, 'Junko' acerolas showed equal skin L* and C^*_{ab}, SS, and SS/TA values between maturity stages 1 and 2, as well as higher TA and lower AA in fruit harvested at the maturity stage 2, compared with fruit harvested at the maturity stage 1 (Table 2). At 7 days of storage, 'Junko' acerolas harvested at the maturity stage 1 showed higher skin L* and C^*_{ab}, weight loss, SS, SS/TA and AA concentration, as well as lower TA, than acerolas harvested at the maturity stage 2 (Table 2). Similar results were observed at 14 days of storage, but with equal SS and AA concentration between maturity stages (Table 2).

The observed changes in acerola color parameters L* and C^*_{ab}, weight loss, SS, AT, SS/TA, and AA in response to different maturity stages along storage agree with quality changes observed in previous studies that have characterized acerola ripening behavior after harvest and during storage (Alves *et al.*, 1995; Carrington & King, 2002; Ribeiro & Freitas, 2020).

Final considerations

According to previous studies, some ripening changes are ethylene dependent, whereas others are ethylene independent (Van Der Straeten *et al.*, 2020). In climacteric fruit, external ethylene has been shown to accelerate some physicochemical changes, such as the reduction on TA

and AA in mango (Silva *et al.*, 2012). In non-climacteric fruit, external ethylene can affect sugar and anthocyanins contents, antioxidant activity, skin color, as well as TA in a genotype dependent manner, implying that each genotype can have a different response (Tian *et al.*, 2000; Villarreal *et al.*, 2010; Costa *et al.*, 2014; Elmi *et al.*, 2017).

Acerola harvested at the maturity stage 2 showed skin color change from green to red and loss of flesh firmness, characterizing fruit ripening during storage. However, acerolas showed no evident changes in response to external ethylene, such as the autocatalytic ethylene production, followed by an increase in respiration rates, in addition to other quality changes. Therefore, although previous studies have classified acerola as a climacteric fruit (Alves *et al.*, 1995; Carrington & King, 2002), our results suggest that acerola has an intermediate metabolism, combining the lack of external ethylene responses with physicochemical changes during storage at 12 °C.

The limited effect of exogenous ethylene on acerola ripening could also suggest that the baseline levels of ethylene produced by the system 1 (<10 μL L^{-1}) were sufficient to saturate the cellular responses leading to fruit changes during storage. On the other hand, ripening of 'Flor Branca' and 'Junko' acerolas could be ethylene independent. Indeed, studies accomplished in our laboratory have shown that treating 'Flor Branca' and 'Junko' acerolas at harvest with an inhibitor of ethylene perception, 1-methylcyclopropene, has no effect on fruit quality during storage (unpublished data), suggesting that ethylene has very limited effect on postharvest quality of acerolas.

In addition to the role of external ethylene on acerola ripening, our study has shown that 'Flor Branca' and 'Junko' acerolas harvested at the maturity stage 2 (density <1 g cm^{-3}) reached the desirable quality for consumption after 14 days of storage, whereas acerolas harvested at the maturity stage 1 (density >1 g cm^{-3}) did not achieve full ripening at the end of storage. These results show that classification of acerolas by maturity based on fruit density was an effective approach that can be used by the acerola industry to separate green acerolas for fresh consumption or ascorbic acid extraction.

CONCLUSIONS

'Flor Branca' and 'Junko' acerolas harvested with green skin and density < 1 g cm^{-3} have ripening behavior that combines the lack of external ethylene responses with quality changes during storage at 12 °C.

'Flor Branca' and 'Junko' acerolas harvested with density <1 g cm^{-3} change skin color from green to red, whereas acerolas harvested with density >1 g cm^{-3} do not change skin color during storage at 12 °C.

The classification of green acerolas by density can be an effective approach to determine fruit maturity for fresh consumption or ascorbic acid extraction.

Table 1: Skin lightness (L) and chroma (C), weight loss (WL), soluble solids (SS), titratable acidity (TA), SS/TA ratio, and ascorbic acid content (AA) of 'Flor Branca' acerolas harvested at two maturity stages, treated or not treated at harvest with ethylene and kept under cold storage for 14 days.

Maturity	1 day of storage						
	L	C	WL (%)	SS (%)	TA (%)	SS/TA	AA (%)
1	53.6 a	38.9 a	0.00	8.3 a	1.51 b	5.51 a	3.07 a
2	55.6 a	39.2 a	0.00	7.6 b	1.62 a	4.70 b	2.56 b
CV (%)	2.37	3.35	0.00	2.10	2.44	1.55	3.86
Maturity	**7 days of storage**						
	L	**C**	**WL (%)**	**SS (%)**	**TA (%)**	**SS/TA**	**AA (%)**
1	55.0 b*	41.1 b	4.29 a	8.1 a	1.78 b	4.57 a	3.19 a
2	58.7 a	42.6 a	3.13 b	7.5 b	1.85 a	4.05 b	2.77 b
CV (%)	3.26	2.39	10.41	2.50	3.03	2.18	4.22
Maturity	**14 days of storage**						
	L	**C**	**WL (%)**	**SS (%)**	**TA (%)**	**SS/TA**	**AA (%)**
1	58.7 a	44.2 a	8.22 a	8.2 a	1.83 b	4.47 a	3.03 a
2	55.6 b	43.2 a	5.90 b	7.5 b	1.97 a	3.80 b	2.80 b
CV (%)	1.10	3.48	8.94	0.90	1.92	1.93	6.04

*Means followed by the same letter in the column do not differ statistically according to the Tukey's test (5%).

Table 2: Skin lightness (L) and chroma (C), weight loss (WL), soluble solids (SS), titratable acidity (TA), SS/TA ratio, and ascorbic acid content (AA) of 'Junko' acerolas harvested at two maturity stages, treated or not treated at harvest with ethylene and kept under cold storage for 14 days.

Maturity	1 day of storage						
	L	C	WL (%)	SS (%)	TA (%)	SS/TA	AA (%)
1	50.9 a	35.9 a	0.00	7.6 a	1.95 b	3.91 a	3.74 a
2	51.2 a	35.7 a	0.00	7.4 a	2.16 a	3.44 a	3.57 b
CV (%)	2.18	2.99	0.00	1.91	1.36	2.61	1.86
Maturity	7 days of storage						
	L	C	WL (%)	SS (%)	TA (%)	SS/TA	AA (%)
1	52.0 a	35.0 a	4.97 a	7.9 a	2.22 b	3.56 a	3.88 a
2	50.2 b	32.5 b	4.37 b	7.5 b	2.44 a	3.10 b	3.72 b
CV (%)	2.74	5.59	3.84	3.32	3.15	2.48	2.37
Maturity	14 days of storage						
	L	C	WL (%)	SS (%)	TA (%)	SS/TA	AA (%)
1	51.8 a	34.8 a	7.98 a	6.8 a	1.84 b	3.71 a	3.55 a
2	41.8 b	26.4 b	7.06 b	7.0 a	2.18 a	3.23 b	3.48 a
CV (%)	6.45	9.0	3.72	5.21	3.58	2.84	4.46

*Means followed by the same letter in the column do not differ statistically according to the Tukey's test (5%).

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