Quality of Rubi grapes coated with Aloe vera L. gel in the pre-harvest

Karoline Kruger Carvalho Eing[1] , Cacilda Márcia Duarte Rios Faria[1] , Aline José Maia[1] , Carla Garcia[1] , Felipe Carvalho[1]* , Renato Vasconcelos Botelho[1]

[1]Midwest State University, Guarapuava, Brazil
*Corresponding author, e-mail: felipe.c.gorpa@gmail.com

Abstract

The use of edible coatings is one of the technologies that has been studied for the maintenance of post-harvest quality of fruits; they can function as a barrier for water loss, change gas exchange, and improve fruit appearance. *Aloe vera* gel, which is rich in polysaccharides, is one of the of coatings that has been tested for this purpose. In this context, the objective of this work was to evaluate the effect of pre-harvest application of *A. vera* gel in the post-harvest quality of Rubi grapes. The treatments used were: *A. vera* gel at the rates of 100, 200, and 300 mL L^{-1}, chitosan (160 g L^{-1}), and distilled water (control). The following post-harvest characteristics were evaluated: titratable acidity (TA), soluble solid (SS) contents, SS/TA, color indexes (brightness, hue, and chroma), and anthocyanin contents. The coatings with *Aloe vera* gel L. improved the post-harvest quality of Rubi grapes, by decreasing titratable acidity, increasing SS/TA, and improving color indexes. The coatings also increased anthocyanin contents. Thus, the use *Aloe vera* gel is recommended for the coating of Rubi grapes in the pre-harvest period.

Keywords: anthocyanins, babosa, phenolic compounds, post-harvest, *Vitis vinifera* L.

Introduction

Grapes are highly perishable fruits, with post-harvest losses estimated in 27%. Several technologies can be used for the maintenance of fruit quality and reduce these losses (Freitas et al., 2008; Chitarra & Chitarra, 2005). The use of edible coatings is one of the techniques that has been studied; it forms a protective layer than can maintain the quality and extend the shelf life of fruits (Bourtoom, 2008; Silva et al., 2011).

Edible coats can be defined as substances applied to the surface of fruits and vegetables that provide a thin and semipermeable cover, promoting an internal balance of gases involved in respiration and, consequently, delaying senescence. In addition, it prevents water loss and occurrence of rotting, and enriches the product with nutrients, vitamins, and antioxidant agents (Rodrigues et al., 2020). Several substances have been used as raw material for fruit coatings, such as chitosan, cassava starch, sodium alginate, *A. vera* gel, glycerol, cashew gum, and green tea (Costa et al., 2022; Turquett et al., 2021; Correio et al., 2018; Bastos et al., 2018).

Aloe vera is an herbaceous plant with thick and succulent leaves, which have medicinal properties due to their vitamin, mineral, amino acid, enzyme, and carbohydrate contents (Fratari et al., 2021). The gel obtained from *A. vera* has the attributes needed to be characterizing as an edible coat, since it forms a semipermeable layer on the fruit, and present antioxidant effects (Vieira et al., 2016).

Several studies on the efficiency of *A. vera* gel in the conservation of fruits and vegetables have found increases in shelf life and decreases in post-harvest losses (García-Mera, et al., 2017; Massuti et al., 2018; Costa et al., 2021). However, most studies were carried out using post-harvest treatments. Therefore, the development of

technologies for the use of this coating in field conditions, through pre-harvest application, could bring several economic and logistic advantages, mainly considering non-climacteric fruit, such as grapes.

In this context, the objective of this work was to evaluate the quality of Rubi grapes coated with *A. vera* gel in the pre-harvest.

Material And Methods

The experiment was carried out in a commercial Rubi vineyard in the municipality of Marialva, Paraná, Brazil, (23°27'49.86"S, 51°47'18.74"W, and altitude of 614 m). The region presents a Cfa climate, according to classification of Köppen, with hot and wet summer and some years with dry winter from June to September. The mean temperature is higher than 22 °C in the hottest months and lower than 18 °C in the coldest months. Mean annual rainfall depths vary from 1300 to 1600 mm, with the highest depths in the summer (IAPAR, 2000). The soils of the area were classified as Typic Hapludox (Latossolo Vermelho Eutroferrico and Nitossolo Vermelho Eutroférrico; Santos et al., 2006) of clayey texture and flat to wavy relief. The vines were grafted onto IAC-766-Campinas rootstocks, planted with spacing of 3 × 6 m, and grown in a trellis system, with pruning (10 to 12 gems) carried out on November 11, 2014.

A completely randomized experimental design was used, with six treatments and four replications; each experimental plot consisted of two bunches. The following treatments were used: *A. vera* gel (Babosa Powerful®, 99% a. i.; Extratos da Flora Indústria e Comércio de Cosméticos, Barra Velha, Brazil) at rates of 100, 200, and 300 mL L^{-1}; chitosan (Fishfertil®, FishFértil Indústria e Comércio Ltda, Mogi Mirim, Brazil) at rates of 160 mg L^{-1} a.i. 20 g L^{-1}, diluted in water, according to the manufacturer's recommendations; and distilled water used as a control. All treatments were carried out with total immersion of bunches for 30 seconds, at 20 days before harvest, which was on July 07, 2015.

Soon after the harvest, the bunches were placed in a refrigerated truck (temperature of 3 ± 2 °C and relative humidity of 85%) and taken to the Laboratory of Fruit Production of the State University of the Central West (UNICENTRO), in Guarapuava, PR, Brazil (284 km distant) where they were maintained in cold chamber under the same conditions until the evaluations. The following evaluations were carried out at 24 hours after harvest: soluble solid contents, titratable acidity, SST/TA, color attributes (brightness, hue, and chroma), anthocyanin contents, and index of infection.

1) soluble solid contents: evaluated through refractometry in three berries of each one of the two bunches of the plot, using a portable digital refractometer (PR 100-ATAGO; Atago Brazil, Ribeirão Preto, Brazil), with results expressed as °Brix.

2) titratable acidity: standardized samples of 5 mL were titrated with a standard solution of NaOH 0.1M, the titration final point was the pH = 8.2; the results were expressed in mg 100 g^{-1} of tartaric acid (Brasil, 2005). The SS/TA was calculated by the ratio between values of soluble solid contents and titratable acidity.

3) The color was determined in the epidermis of 3 berries of each experimental plot, in three different points of each berry using a colorimeter (Minolta CR-400; Konica Minolta Sensing Americas Inc., Ramsey, USA), with determinations of L*, a* and b* indexes. The L* coordinate indicates how clear or dark is the sample, with values varying from 0 (totally black) to 100 (totally white); the a* coordinate present values of -80 to +100, with the extremes corresponding to green and red, respectively; and the b* coordinate represents the blue to yellow intensity, with values of -50 (totally blue) to +70 (totally yellow). The parameters L (brightness), a*, and b* enables to calculate the hue angle, and the Chroma. The hue angle is given by: [tangent arc (b*/a*)], and chroma is given by: [(a*2 + b*2)1/2], according to Minolta (1994).

4) Anthocyanins: total anthocyanin contents were determined in a 1-g sample of the Rubi grape peel, using the pH difference method (Giusti & Wrosltad, 2001), which consists in two buffer systems, sodium acetate pH 4.5 (0.4 mol L^{-1}) and potassium chloride pH 1.0 (0.025 mol L^{-1}), using one tube for each buffer. A 200-μL sample was placed in the tube adjusted for 2 mL of buffer solution. A spectrophotometer (UV-1800; Shimadzu Corporation, Kyoto, Japan) was used to measure the absorbance at 700 nm. The absorbance was calculated using the following equation: A = (Amax. vis – A700 nm) pH 1.0 – (Amax vis – A700 nm) pH 4.5. The concentration of pigments in the extract was calculated and presented in cyanidin-3-glucoside. Anthocyanins (mg L^{-1}) = (A × MW × DF × 1000) / (ε × 1), where A = absorbance; MW = molecular weight; DF = dilution factor, and ε = molar absorptivity.

The data were subjected to analysis of variance and significant means were compared by the Tukey's test ($p<0.05$), using the Sisvar 5.6 program (Ferreira, 2011).

Results and Discussion

Soluble solid contents were, in general, below 14° Brix after the harvest (Figure 2A), which is lower than the value established by the Brazilian legislation for the marketing of table grapes, according to the Normative

Instruction/SARC No. 001 (Brasil, 2002). This was due to the non-favorable climate conditions during the fruit maturation stage, which presented excessive rainfalls, since climate factors are essential for this aspect (**Figure 1**).
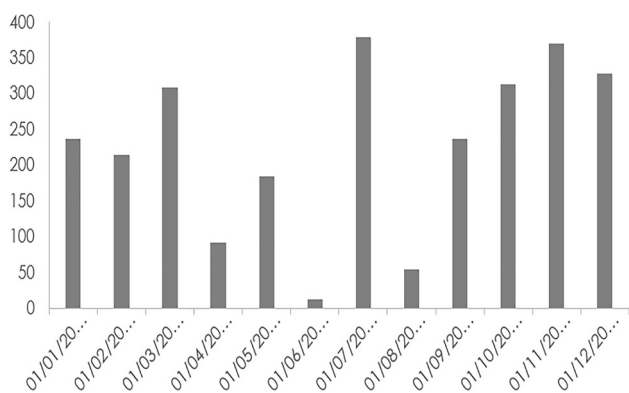

Figure 1. Rainfall data of Marialva, PR, Brazil in 2015, monthly accumulated rainfall (mm) (Brazilian National Institute of Meteorology INMET).

Excess rainfall can hinder the ripening of grapes due to the accumulation of water in the soil, which can dilute the fruit pulp solution, unbalancing its composition; moreover, when the soil remains soaked for a long period, the fruit ripening is delayed (Chitarra & Chitarra, 2005; Gobbato, 1922), thus explaining the low soluble solid contents found in the present work.

The different pre-harvest treatments had no significant effect on soluble solid contents (**Figure 2**A). The titratable acidity of the pulp of grapes decreased due to the pre-harvest treatment with *A. vera* and chitosan for all tested rates, with significant differences from the control (Figure 2B). The treatment with chitosan presented the highest SS/TA, but with no significant difference from the treatment with *A. vera* at 100 mL L^{-1}, which was not different from the treatment with *A. vera* at 200 mL L^{-1}, all with significantly higher values than the control treatment (Figure 2C).

According to the results of the present experiment, the pre-harvest treatment of Rubi grapes with *A. vera* improves the quality of the grape bunches. Despite no significant differences was found for soluble solid contents, titratable acidity decreased and SS/TA increased, when compared to the control treatment. These results contrast with those reported by Castillo et al. (2010), who found no effect of treatments with *A. vera* in these chemical characteristics for Autumn Royal grapes. The most effective treatments for the improvement of quality of Rubi grapes were those with applications of *A. vera* at 100 and 200 mL L^{-1}, which presented higher SS/TA (Figure 2C). This is an interesting effect that can improve the organoleptic quality of grapes.
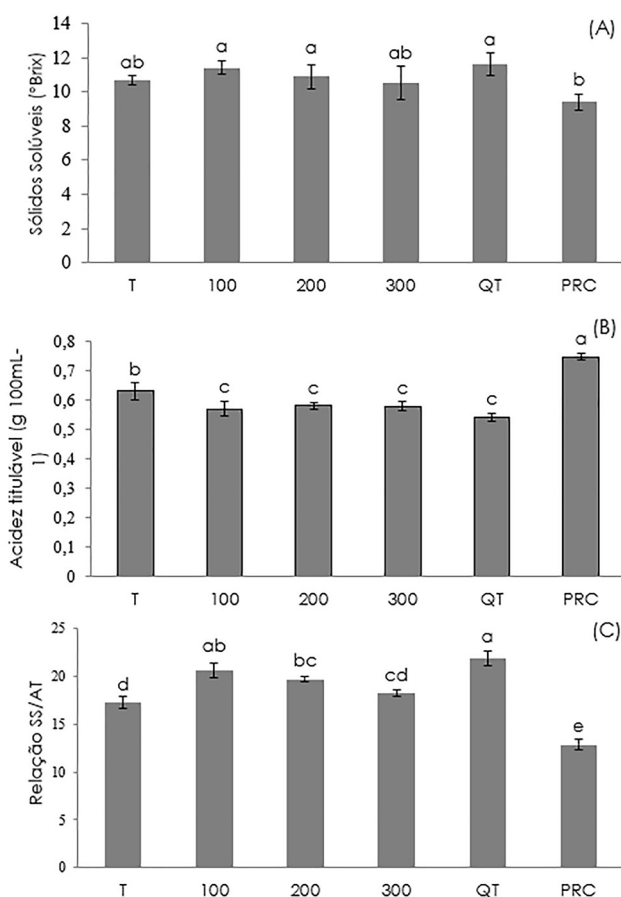

Figure 2. Soluble solid contents (SS) (A), titratable acidity (TA) (B) and SS/TA (C) of Rubi grapes treated with different products in the pre-harvest. C = control, 100 = 100 mL L^{-1} of *A. vera*; 200 = 200 mL L^{-1} of *A. vera*; 300 = 300 mL L^{-1} of *A. vera*; CH = chitosan, PRC = Prociodione. Bars with the same letters are not different from each other by the Tukey's test ($p \leq 0.05$). Vertical lines represent the standard deviation ($n = 4$) (Guarapuava, PR, Brazil, 2017).

The results of colorimetry evaluations of the epidermis of berries of Rubi grapes showed significant differences for all indexes. The pre-harvest treatments with *A. vera* at 100 mL L^{-1} and chitosan significantly decreased the brightness of the berries, when compared to the control treatment, i.e., the berries were darker (**Figure 3**A).

Chroma is an index connected with color saturation. The pre-harvest treatments with *A. vera* at 100 and 200 mL L^{-1} and chitosan decreased these values in 26.4%, 22.6%, and 23.2%, respectively, when compared to the control (Figure 3B).

When the pre-harvest treatment with *A. vera* was applied at the rate of 100 mL L^{-1}, the hue angle was lower than that of the control, with the epidermis of the berries showing a more intense red color (Figure 3C).

The more intense and brighter the fruit color, the more attractive for the consumer (Adriano et al., 2011); thus, color characteristics are important for the commercial value of fruit products. The brightness, chroma, and hue angle of the Rubi grapes in the different
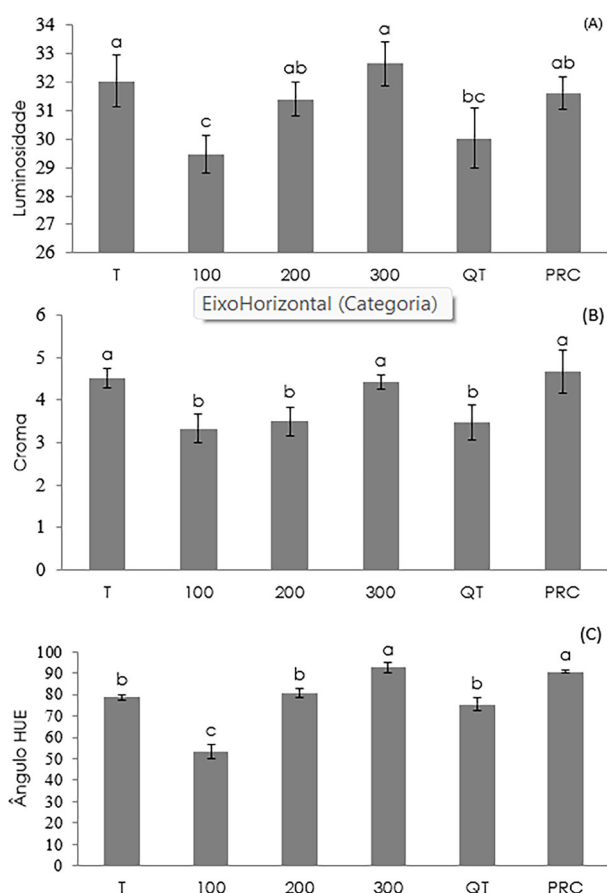
Figure 3. Brightness (A), chroma (B) and hue angle (C) of Rubi grapes treated with different products in the pre-harvest. C = control, 100 = 100 mL L^{-1} of *A. vera*; 200 = 200 mL L^{-1} of *A. vera*; 300 = 300 mL L^{-1} of *A. vera*; CH = chitosan. Bars with the same letters are not different from each other by the Tukey's test (*p*≤0.05). Vertical lines represent the standard deviation (*n* = 4) (Guarapuava, PR, Brazil, 2017).

pre-harvest treatments showed that the rate of 100 mL L^{-1} of *A. vera* significantly improves the color, resulting in bunches with darker, opaque, and reddish-purple grapes (Chitarra & Chitarra, 2005). Similar results were reported by Castillo et al. (2010) in Abarán-Murcia (Spain); they found decreases in values of color indexes in Autumn Royal grapes treated with *A. vera* the 250 mL L^{-1} in the pre-harvest. Regarding the chroma, the *A. vera* treatments at 100 and 200 mL L^{-1} decreased the color saturation of the Rubi grapes, making the fruits more opaque; this decrease in brightness is connected to the development of a protection mechanism in grapes, a natural production of epicuticular wax coating (Côrrea & Boliani, 2001).

The reddish the fruit, the higher its acceptance in the consumer market. Anthocyanins are important red, purple, or violet color compounds for fruits intended for fresh consumption (Chitarra & Chitarra, 2005). Therefore, the grapes coated with *A. vera* presented higher quantity of anthocyanins, making the fruits to be in the best conditions for marketing (**Figure 4**).

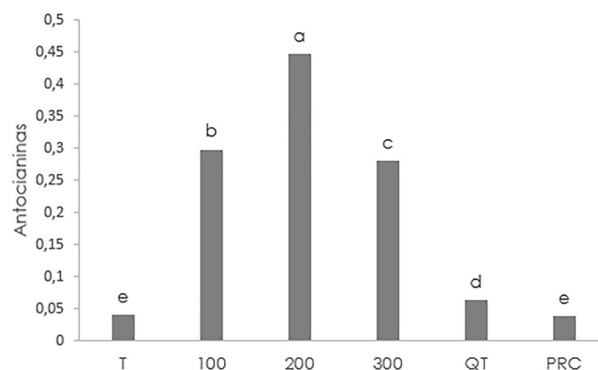The high anthocyanin contents in fruits coated

Figure 4. Anthocyanin contents in Rubi grapes treated with different products in the pre-harvest. C = control, 100 = 100 mL L^{-1} of *A. vera*; 200 = 200 mL L^{-1} of *A. vera*; 300 = 300 mL L^{-1} of *A. vera*; CH = chitosan. Bars with the same letters are not different from each other by the Tukey's test (*p*≤0.05). Vertical lines represent the standard deviation (*n* = 4) (Guarapuava, PR, Brazil, 2017).

with *A. vera* gel, combined with the better appearance of the grapes, are attractive features for consumers, since anthocyanins are strong antioxidants of the flavonoid group, which have the function of inhibit oxidation, thus combating free radicals of organisms and avoiding lipid peroxidation; therefore, they are important in human diet, since these effects can prevent health problems, such as cardiovascular and degenerative diseases and tumors (Conceição et al., 2017).

The pre-harvest application of *A. vera* at 100 mL L^{-1} to Rubi grapes presented, in general, the most promising results, since the coating improved the quality of grapes related to chemical characteristics and color aspects and, mainly, increased anthocyanin contents, which give nutraceutical qualities to the fruit and add value to bunches of Rubi grapes, making them more attractive to the consumer.

Conclusion

The pre-harvest application of *Aloe vera* gel to Rubi grapes improved the quality of the fruits. The *Aloe vera* gel rate of 100 mL L^{-1} presented the best results, with decreases in titratable acidity of the pulp, improvements in epidermis color, and increases in anthocyanin contents.

Acknowledgements

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