

ISSN 1678-3921

Journal homepage: www.embrapa.br/pab

For manuscript submission and journal contents,
access: www.scielo.br/pab

Eucalyptus staigeriana essential oil in the control of postharvest fungal rots and on the sensory analysis of grapes

Carine Pedrotti⁽¹⁾ ,
Tayná Ribeiro Trentin⁽¹⁾ ,
Hélen Corso Cavião⁽¹⁾ ,
Johnatan Vilasboa⁽¹⁾ ,
Fernando Joel Scariot⁽²⁾ ,
Sergio Echeverrigaray⁽²⁾ ,
Luciani Tatsch Piemolini-Barreto⁽³⁾ ,
Joséli Schwambach⁽¹⁾ 

⁽¹⁾ Universidade de Caxias do Sul, Instituto de Biotecnologia, Laboratório de Controle Biológico Doenças de Plantas e Laboratório de Biotecnologia Vegetal, Rua Francisco Getúlio Vargas, nº 1.130, Petrópolis, CEP 95070-560 Caxias do Sul, RS, Brazil. E-mail: carine_pedrotti@yahoo.com.br, trentintayna@gmail.com, helen_cor94@hotmail.com, johnatan.vilasboa@gmail.com, jschwambach@ucs.br

⁽²⁾ Universidade de Caxias do Sul, Instituto de Biotecnologia, Laboratório de Pesquisas Enológicas e Bebidas e Laboratório de Microbiologia Aplicada, Rua Francisco Getúlio Vargas, nº 1.130, Petrópolis, CEP 95070-560 Caxias do Sul, RS, Brazil. E-mail: ferjscarriot@gmail.com, selaguna@ucs.br

⁽³⁾ Universidade de Caxias do Sul, Instituto de Biotecnologia, Laboratório de Análises e Pesquisas em Alimentos, Rua Francisco Getúlio Vargas, nº 1.130, Petrópolis, CEP 95070-560 Caxias do Sul, RS, Brazil. E-mail: ltbarre@ucs.br

 Corresponding author

Received

November 25, 2021

Accepted

April 01, 2022

How to cite

PEDROTTI, C.; TRENTIN, T.R.; CAVIÃO, H.C.; VILASBOA, J.; SCARIOT, F.J.; ECHEVERRIGARAY, S.; PIEMOLINI-BARRETO, L.T.; SCHWAMBACH, J. *Eucalyptus staigeriana* essential oil in the control of postharvest fungal rots and on the sensory analysis of grapes. **Pesquisa Agropecuária Brasileira**, v.57, e02782, 2022. DOI: <https://doi.org/10.1590/S1678-3921.pab2022.v57.02782>.

Abstract – The objective of this work was evaluate the effect of *Eucalyptus staigeriana* essential oil on *Colletotrichum gloeosporioides* and *Greeneria uvicola* mycelial growth and conidia germination on grapes, as well as its potential for the control of postharvest rot diseases and its effect on the organoleptic properties of grapes. The essential oil (EO) showed in vitro antifungal activity against both pathogens, with fungicidal effect on mycelial growth and on conidia germination at the concentrations of 1.0 and 0.5 $\mu\text{L mL}^{-1}$, respectively. The EO volatile compounds had a fungistatic effect on the mycelial growth of *C. gloeosporioides* and a fungicidal effect on *G. uvicola*. At postharvest, the EO reduced the incidence of ripe rot up to 75% and 86% in the preventive and curative treatments, respectively, and the incidence of bitter rot up to 54% in the curative treatment. Since the EO does not affect significantly grape sensory properties, it does not affect the consumption intention of grapes treated with the EO. The EO of *E. staigeriana* is efficient in the in vitro control of both pathogens; moreover, it is also efficient in the control of the incidence of postharvest fungal rot diseases, mainly in the curative treatment.

Index terms: *Colletotrichum gloeosporioides*, *Greeneria uvicola*, alternative control, bitter rot, ripe rot.

Óleo essencial de *Eucalyptus staigeriana* no controle de podridões fúngicas no período pós-colheita e na análise sensorial de uvas

Resumo – O objetivo deste trabalho foi avaliar o efeito do óleo essencial de *Eucalyptus staigeriana* sobre o crescimento micelial e a germinação de conídios de *Colletotrichum gloeosporioides* e *Greeneria uvicola* em uvas, assim como o seu potencial para o controle de podridões no período pós-colheita e o seu efeito nas propriedades organolépticas das uvas. O óleo essencial (OE) apresentou atividade antifúngica in vitro contra ambos os patógenos, com efeito fungicida sobre o crescimento micelial e sobre a germinação de conídios, nas concentrações de 1,0 e 0,5 $\mu\text{L mL}^{-1}$, respectivamente. Os compostos voláteis do OE exibiram efeito fungistático sobre o crescimento micelial de *C. gloeosporioides* e efeito fungicida sobre *G. uvicola*. Na pós-colheita, o OE reduziu a incidência da podridão-madura em até 75 e 86%, nos tratamentos preventivos e curativos, respectivamente, e a incidência da podridão-amarga em até 54% no tratamento curativo. Como o OE não influencia significativamente as propriedades sensoriais das uvas, não afeta a intenção de consumo para uvas tratadas com o OE. O OE de *E. staigeriana* é eficiente para o controle in vitro de ambos os patógenos; além disso, também é eficiente no controle da incidência de podridões fúngicas no período pós-colheita, principalmente no tratamento curativo.

Termos para indexação: *Colletotrichum gloeosporioides*, *Greeneria uvicola*, controle alternativo, podridão-amarga, podridão-da-uva-madura.



Introduction

The major fact causing fruit loss is the postharvest decay in the supply chain, which results in significant economic impact for the food industry. That is the fruit marketing chain's case, due to previously established infections that come from injuries during harvesting operations (Prusky, 2011; Pedrotti et al., 2019a).

Bunch rots in grapes are caused by *Colletotrichum gloeosporioides* (Penz.) Penz. & Sacc. and *Greeneria uvicola* (Berk. & M.A. Curtis) Punith., responsible for ripe rot and bitter rot, respectively (Steel et al., 2007; Greer et al., 2011). Bunch rots are the most frequent and severe diseases of grape berries in Serra Gaúcha – in the subtropical highlands of the state of Rio Grande do Sul (RS), Brazil – which has grape production for both processing and in natura consumption (Longland & Sutton, 2008; Greer et al., 2011; Echeverrigaray et al., 2020).

Chemical agents are typically used to reduce fruit decay. However, due to growing concerns over food safety containing chemical additives, natural antifungal products for fruit preservation are attracting increasing attention. Some essential oils (EOs) could be an alternative for chemical fungicides because they are biodegradable natural products, with antifungal properties, low toxicity, and low environmental impact (Pandey et al., 2017).

Eucalyptus genus belongs to the Myrtaceae family and comprises about 900 species extensively spread worldwide (Brooker & Kleing, 2006; Dhakad et al., 2018). This genus contains plants with volatile oils in their leaves and it has been commercially used to produce EOs in the pharmaceutical, toiletry, cosmetics, and food industries. Previous studies have reported the antifungal properties of *Eucalyptus* EOs against various phytopathogens in the postharvest of fruits (Jhalegar et al., 2015; Abd-El-Latif, 2016; Pedrotti et al., 2021).

The objective of this work was evaluate the effect of *E. staigeriana* essential oil on *C. gloeosporioides* and *G. uvicola* mycelial growth and conidia germination on grapes, as well as its potential for the control of postharvest rot diseases and its effect on the organoleptic properties of grapes.

Materials and Methods

Strains of *Colletotrichum gloeosporioides* (A021/17C) and *Greeneria uvicola* (A021/17B) were isolated from grapes collected in the municipality of Bento Gonçalves, RS, Brazil, and maintained at 25±2°C in potato dextrose agar (PDA) medium. For the molecular identification, total DNA was extracted from fungal mycelia according to Tappia-Tussell et al. (2006), then used in the PCR amplification of internal transcribed sequence (ITS-5.8S rDNA), and its products were sequenced as described by Echeverrigaray et al. (2020). The DNA sequences were compared with those deposited in the GeneBank Database using the nBLAST algorithm (NCBI). Both isolates were classified by the sequencing of large subunit RNA gene (GenBank codes A21/17C - MN759013 and A21/17B – MW582304).

Leaves of *E. staigeriana* were collected in the municipality of Caxias do Sul, RS, Brazil, in September 2017. During the month of collection, the climatic conditions showed 17°C average temperature, 182 mm precipitation, and 79.7% relative humidity. Leaves were oven-dried at 30°C until a constant mass was obtained.

The extraction of *E. staigeriana* leaf EO was performed from dried plant leaves, using the steam distillation method in a Clevenger-type apparatus for 1 hour, according to Pedrotti et al. (2021). For the identification and quantification of EO compounds, the method described in Pedrotti et al. (2019b) was used. The chromatographic peaks of each component were analyzed and identified by comparison between the obtained spectra and those from the Wiley library, and by comparison of the calculated linear retention indexes (LRIs) and the literature references (Adams, 2005). The LRI values were calculated with the Van den Dool & Krats (1963) equation and a standard solution of C8-C26 hydrocarbons.

The EO antifungal effect was assessed both for its contact and volatile phase effects against mycelial growth of the phytopathogens. The contact phase effect of EO was determined using PDA medium according to Pedrotti et al. (2019b). For that, different concentrations of EO (0.0, 0.25, 0.5, 1.0, and 1.5 µL mL⁻¹) were emulsified with Tween 20 (1:1) and added to the PDA culture medium. These emulsions were poured into 9 cm (∅) Petri dishes (20 mL volume) and inoculated with 5 mm (∅) agar disks colonized

by *C. gloeosporioides* or *G. uvicola* obtained from seven-day-long pre-cultures. Tests were carried out in triplicate with fifteen plates for each treatment. Incubation was conducted in a growth chamber at $25\pm 2^\circ\text{C}$ in 12-hour photoperiod. The evaluation was recorded on the 3rd, 5th, 7th, 10th, and 14th days by measuring the diameter of the mycelial growth.

The EO volatile phase effect on the mycelial growth of the phytopathogens was evaluated using the method adopted by Pedrotti et al. (2019b), as follows: agar disks with 5 mm (\varnothing) colonized by *C. gloeosporioides* or *G. uvicola* were placed at the center of Petri dishes containing PDA medium (20 mL); aliquots of EO (100 μL) at 12.5, 25, and 50 μL , emulsified with 0.1% Tween 20, and pure EO (100 μL , devoid of Tween 20) were applied onto a cotton ball attached to the inner face of a Petri dish lid. The control treatment consisted of 100 μL of 0.1% Tween 20 solution. Tests were carried out in triplicate with fifteen plates for each treatment. Incubation was conducted in a growth chamber at $25\pm 2^\circ\text{C}$ in 12-hour photoperiod. The evaluation was recorded on the 3rd, 5th, 8th, 10th, 13th, and 15th days by measuring the diameter of the mycelial growth.

Transfer experiments were performed according to Pedrotti et al. (2019a), to distinguish the fungicidal and fungistatic effects of EO.

The antifungal activity of EO on conidia germination was evaluated on the basis of a protocol described by Pedrotti et al. (2019b). Conidia of *C. gloeosporioides* and *G. uvicola* were harvested from 14-day-old fungal colonies grown in PDA ($25\pm 2^\circ\text{C}$, in 12-hour photoperiod). Conidial suspensions at concentration of 1×10^6 conidia mL^{-1} were used. The effect of different EO concentrations (0.0, 0.25, 0.5, 1.0, and 1.5 $\mu\text{L mL}^{-1}$) were evaluated. The evaluations were performed after 6, 12, and 24 hours. Tests were conducted in triplicate with fifteen replicates per treatment.

For the in vivo evaluation of antifungal activity in the postharvest period, 'Isabella' grapes (*Vitis labrusca* \times *Vitis vinifera*) were obtained from a vineyard in the municipality of Bento Gonçalves, RS, Brazil. The collection of grapes was followed by surface-sanitization with 1.5% sodium hypochlorite (3 min), then fruit were rinsed with sterile distilled water. Conidia suspension of *C. gloeosporioides* and *G. uvicola* were obtained as above described. Conidial suspensions at 1×10^6 conidia mL^{-1} concentration were used. The treatments were as follows: an absolute control (nontreated

grapes); EO control [EO emulsified with Tween 20 (Synth) (1:1)] and added to sterile water at 1.0, 2.0, and 3.0 $\mu\text{L mL}^{-1}$ concentrations; inoculated control (grapes inoculated with conidia suspension); and preventive and curative treatment with *E. staigeriana* EO (EO emulsified with Tween 20 (1:1) and added to the sterile water at 1.0, 2.0, and 3.0 $\mu\text{L mL}^{-1}$ concentrations. The EO antifungal activity on grapes was evaluated according to the method described by Pedrotti et al. (2019a). Wounds (approximately 2 mm deep) were made on ten berries in grape clusters. In the curative treatment, a conidia suspension of *C. gloeosporioides* or *G. uvicola* (10 μL in each wound) was inoculated, and after 24 hours, grape clusters were sprayed with *E. staigeriana* EO at different concentrations. In the preventive treatment, the same EO concentrations were sprayed on grape clusters, and after 24 hours, these clusters were inoculated with a conidia suspension of *C. gloeosporioides* or *G. uvicola* (10 μL in each wound). Grapes were placed in plastic boxes and incubated at $25\pm 2^\circ\text{C}$ / 80% relative humidity in 16-hour photoperiod. The incidence was evaluated for the presence or absence of symptoms of the diseases, and severity was evaluated, using a scale according to the berry area affected by the disease (Pedrotti et al., 2021). The experiment consisted of four treatments with 12 grape clusters for each treatment. This assay was repeated three times.

For the sensory analysis, mature, and asymptomatic 'Isabella' grapes were used in the experiments. Berries were removed from the rachis, but peduncles and pedicels were kept. The treatments consisted of: a control (washed with distilled and autoclaved water); and a treatment with *E. staigeriana* EO [EO was emulsified with Tween 20 (1:1) and added to sterile water at 1 $\mu\text{L mL}^{-1}$ concentration]. Berries of both treatments were dried at room temperature ($24\pm 2^\circ\text{C}$). Samples were prepared 24 hours before the sensory evaluation. A panel of 50 untrained consumers participated in the sensory test. The consumers were conducted to individual booths at room temperature, under white light. The samples were provided in a transparent plastic container with three berries, accompanied with mineral water ($22\pm 2^\circ\text{C}$) to clean the palate between the samples. The containers were coded with three-digit random numbers. Two testing sessions were carried out in sequence, and consumers filled out a sensory form for each one. In the first stage, the samples were

served in a blind test, asking the consumer to evaluate the sample. Consumers tasted each sample and evaluated flavor, appearance, aroma, and color using a 10-point hedonic scale (10 = liked very much, 1 = disliked very much). In the second stage, new samples were given to consumers under the same conditions above described, but the samples were identified. The consumers evaluated the characteristics (better, equal, or worse than the control), and the degree of difference (none, weak, moderate, high, or extreme) between the treatment with *E. staigeriana* EO (unidentified) and the control (identified). Moreover, consumption intent was also evaluated using a 5-point hedonic scale (1 = certainly would not buy, 5 = certainly would buy).

All statistical analysis was performed using SPSS 22.0 software. The Kolmogorov-Smirnov test was used to determine the data normality, and the homogeneity of variances was determined using Levene's test. The data were subjected to analysis of variance, and the threshold for statistical significance was set at 5% probability. In the case of statistical significance, the Tukey's or Dunnett's T3-test was applied to compare the means, at 5% probability.

Results and Discussion

Essential oil extracted by steam distillation from dried leaves of *E. staigeriana* yielded 2.5% (mL 100 g⁻¹ dried leaves). The analyses allowed of the identification of 23 compounds (Table 1), and the major ones found were: 29.34% citral (18.16% geranial and 11.18% neral); 18.85% 1,8-cineole; and 14.32% limonene. Overall, EO composition consisted of 78.83% monoterpenes (19.61% hydrocarbons and 59.22% oxygenated), 0.40% sesquiterpene hydrocarbons, 12.97% esters, and 0.09% other compounds. The EO's chemical composition was similar to others previously reported (Macedo et al., 2010; Tomazoni et al., 2017; Pedrotti et al., 2019b). Thus, we can conclude that the composition of EO is a highly stable oil type.

The antifungal evaluation of *E. staigeriana* EO showed that the inhibitory effect on the mycelial growth increased proportionally with oil concentrations; mycelial growth was also affected by treatment duration. The mycelial growth of *C. gloeosporioides* (Figure 1 A) and *G. uvicola* (Figure 1 B) in the contact phase resulted in the complete inhibition from the EO application at 1 $\mu\text{L mL}^{-1}$ concentration. Fungicidal

action was confirmed by the transfer experiment, in which no mycelial growth was observed for both fungi species. For the treatments at 0.25 and 0.5 $\mu\text{L mL}^{-1}$ EO against *C. gloeosporioides*, there was a significant mycelial growth inhibition, in comparison with the control, until the 3rd and 5th days, respectively (Figure 1 A). For *G. uvicola*, a significant mycelial growth inhibition could be observed until the 7th day, at 0.25 $\mu\text{L mL}^{-1}$ EO concentration. EO at 0.5 $\mu\text{L mL}^{-1}$ significantly inhibited the mycelial growth until the 14th day (Figure 1 B).

In its volatile phase, the effect of EO concentration at 12.5 μL on the mycelial growth of *C. gloeosporioides* guaranteed a significant inhibition until the 10th day (Figure 2 A). However for higher concentrations, such effect could be observed until the 15th day. Against *G. uvicola*, 12.5 μL and 25 μL EO allowed of

Table 1. Chemical composition of *Eucalyptus staigeriana* essential oil extracted by steam distillation.

Compound	LRI calc. ⁽¹⁾	LRI lit. ⁽²⁾	Content (%)
Monoterpene hydrocarbons			19.61
α -pinene	1029	1028	0.70
α -phellandrene	1160	1160	0.09
Myrcene	1165	1166	0.49
Limonene	1198	1199	14.32
γ -terpinene	1240	1240	0.20
Cis- β -ocimene	1250	1251	0.23
p -cymene	1270	1270	1.00
δ -terpinene	1280	1284	2.58
Oxygenated monoterpenes			59.22
1,8-cineole	1208	1210	18.85
Citronellal	1489	1491	0.07
Linalool	1528	1528	0.84
Terpinen-4-ol	1558	1564	1.04
Neral	1662	1666	11.18
Geranial	1745	1744	18.16
Citronellol	1775	1773	1.68
Nerol	1811	1810	2.82
Geraniol	1853	1853	4.58
Sesquiterpene hydrocarbons			0.40
β -caryophyllene	1555	1557	0.40
Esters			12.97
Citronellyl acetate	1645	1648	0.94
Terpinyl acetate	1707	1709	7.04
Neryl acetate	1739	1742	2.81
Geranyl acetate	1766	1766	2.18
Others			0.09
Geranic acid	2346	2347	0.09

⁽¹⁾Calculated linear retention index. ⁽²⁾Linear retention index according to literature data.

significant inhibition until the 10th and the 15th days, respectively. At the concentration of 50 $\mu\text{L mL}^{-1}$ EO, no growth was observed, and the transfer test confirmed the fungicidal activity (Figure 2 B).

The germination of *C. gloeosporioides* and *G. uvicola* conidia was completely inhibited at 0.5 $\mu\text{L mL}^{-1}$ EO concentration in all times of evaluation (Figure 3 A and B). The 0.25 $\mu\text{L mL}^{-1}$ EO treatment showed a significant reduction of *C. gloeosporioides* conidia germination in comparison with the control; for *G. uvicola*, conidia germination could only be observed at 24 hours after EO application.

These results show that *E. staigeriana* EO is efficient in the in vitro control of *C. gloeosporioides* and *G. uvicola*. Similarly to these results, Tomazoni et al. (2017, 2018) and Pedrotti et al. (2019b) showed that *E. staigeriana* EO had fungicidal activity on the mycelial growth and conidia germination of *Alternaria solani*, *Stemphylium solani*, *Botrytis cinerea*, and *Colletotrichum acutatum*.

The application of *E. staigeriana* EO results on the control of disease development in postharvest of grapes are presented (Table 2). All evaluated EO concentrations (1, 2, and 3 $\mu\text{L mL}^{-1}$) were efficient for the incidence reduction of the disease caused by

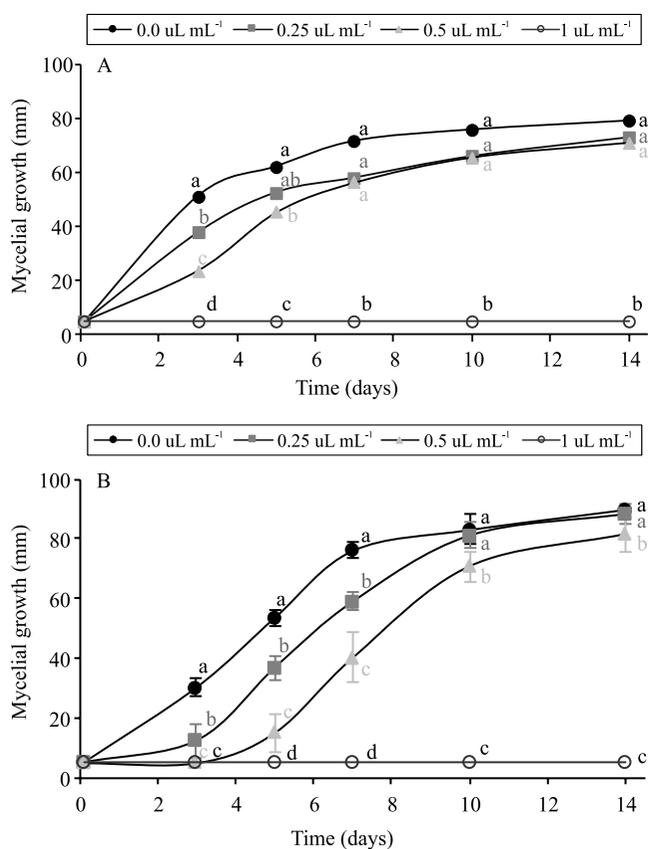


Figure 1. Effect of increasing concentrations of *Eucalyptus staigeriana* essential oil (contact phase), added to the solid media, on the mycelial growth of *Colletotrichum gloeosporioides* (A) and *Greeneria uvicola* (B). Values are the mean of 15 replicates per treatment \pm standard deviation. Means followed by equal letters, among the different essential oil concentrations evaluated in each day, do not differ by Dunnett's T3-test, at 5% probability.

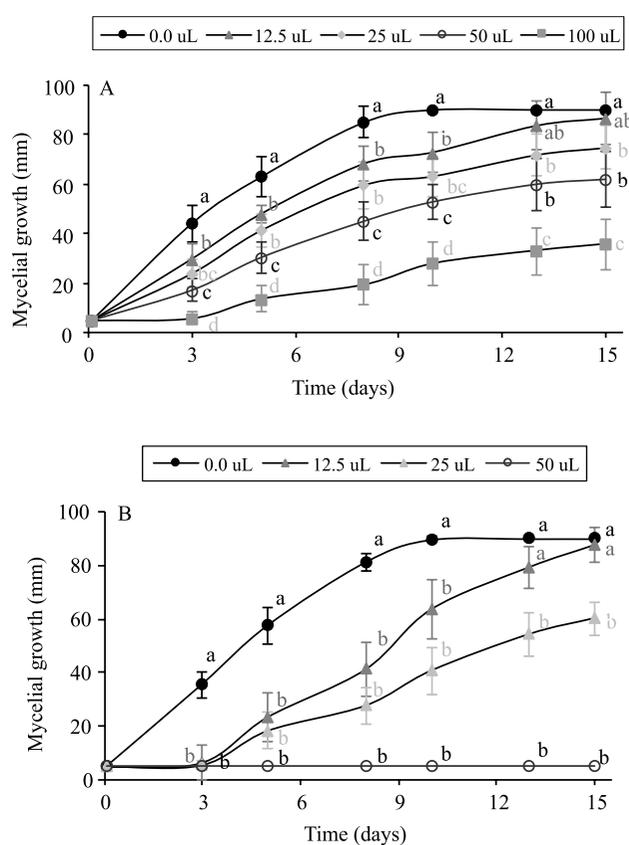


Figure 2. Effect of increasing concentrations of *Eucalyptus staigeriana* essential oil (volatile phase) applied on the lid, on the mycelial growth of *Colletotrichum gloeosporioides* (A) and *Greeneria uvicola* (B). Values are the mean of 15 replicates per treatment \pm standard deviation. Means followed by equal letters, among the different essential oil concentrations evaluated in each day, do not differ by Dunnett's T3-test, at 5% probability.

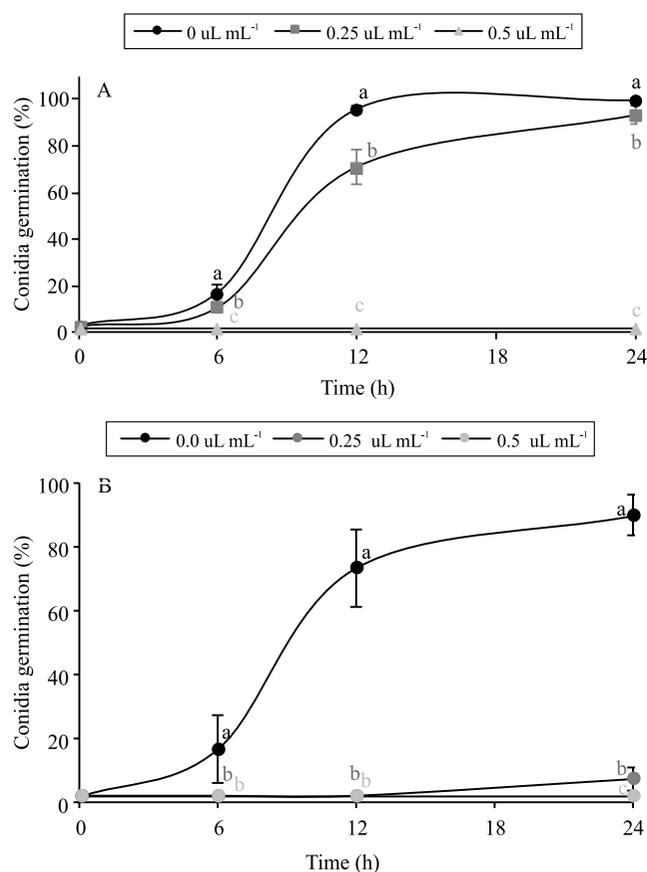


Figure 3. Effect of increasing concentrations of *Eucalyptus staigeriana* essential oil on the conidia germination of *Colletotrichum gloeosporioides* (A) and *Greeneria uvicola* (B) evaluated at different times. Values are the mean of 15 replicates per treatment \pm standard deviation. Means followed by equal letters, among the different essential oil concentrations evaluated in each day, do not differ by Tukey's test, at 5% probability.

C. gloeosporioides in the preventive treatment by 57, 65, and 75%, at 1.0, 2.0, and 3.0 $\mu\text{L mL}^{-1}$, respectively, and in the curative treatment (reduction of 83, 85, and 86% at 1.0, 2.0, and 3.0 $\mu\text{L mL}^{-1}$, respectively). In the preventive and curative treatments (in all evaluated concentrations), the severity of the disease was equal to that of the inoculated control (1%), which shows that the EO had no effect on the severity of the ripe rot. The EO also reduced the incidence of the disease caused by *G. uvicola* only in the curative treatment (by 54, 33, and 23%, at 1.0, 2.0, and 3.0 $\mu\text{L mL}^{-1}$, respectively). Thus, *E. staigeriana* EO appears to be more efficient for controlling the incidence of disease caused for *C. gloeosporioides* in the preventive and curative treatments than in the control of the incidence of *G. uvicola*, which was effective only in the curative treatment. Its low efficacy in the control of bitter rot (*G. uvicola*) may be associated with the high severity of this disease. This result shows that *E. staigeriana* EO was efficient for the control of postharvest incidence of fungal rots diseases, mainly in the curative treatment, and it can be applied in the postharvest chain for the storage of table grapes. The present study corroborates the findings by Pedrotti et al. (2021), who reported that the efficacy of *E. staigeriana* EO reduced the incidence and severity of disease caused by *B. cinerea* and the incidence of disease caused by *C. acutatum*, in preventive and curative treatments.

Considering the effectivity and the antifungal properties of many EO types, previous studies (Zuzarte et al., 2012; Cabral et al., 2013; Scariot et al.,

Table 2. Essential oil of *Eucalyptus staigeriana* effects on the incidence and severity of diseases caused by *Colletotrichum gloeosporioides* and *Greeneria uvicola* to 'Isabella' grapes (*Vitis labrusca* \times *Vitis vinifera*)⁽¹⁾.

Treatment	Preventive treatment		Curative treatment	
	Incidence (%)	Severity (%)	Incidence (%)	Severity (%)
<i>Colletotrichum gloeosporioides</i>				
Inoculated control	54.00 \pm 2.19a	1.00 \pm 0.00a	54.00 \pm 2.19a	1.00 \pm 0.00a
1.0 $\mu\text{L mL}^{-1}$	23.30 \pm 2.14b	1.00 \pm 0.00a	9.30 \pm 1.55b	1.00 \pm 0.00a
2.0 $\mu\text{L mL}^{-1}$	18.70 \pm 1.74b	1.00 \pm 0.00a	8.30 \pm 1.12b	1.00 \pm 0.00a
3.0 $\mu\text{L mL}^{-1}$	14.00 \pm 1.48b	1.00 \pm 0.00a	7.70 \pm 0.88b	1.00 \pm 0.00a
<i>Greeneria uvicola</i>				
Inoculated control	45.30 \pm 2.93a	31.94 \pm 27.83a	45.30 \pm 2.93a	31.94 \pm 27.83a
1.0 $\mu\text{L mL}^{-1}$	40.70 \pm 3.03a	35.94 \pm 17.71a	21.00 \pm 2.43b	34.16 \pm 17.06a
2.0 $\mu\text{L mL}^{-1}$	41.30 \pm 2.96a	26.63 \pm 17.68ab	30.30 \pm 3.31ab	32.52 \pm 17.39a
3.0 $\mu\text{L mL}^{-1}$	42.70 \pm 3.42a	35.34 \pm 18.51a	34.70 \pm 3.15ab	28.54 \pm 19.08a

⁽¹⁾Means followed by equal letters, in the columns, do not differ by Tukey's test, at 5% probability. Values represent the mean of replicates \pm standard deviation.

2020) suggest plasma membrane disruption as one of the main mechanisms of action of EOs, which leads to the loss of membrane integrity, and necrotic death of fungi cell (Sharifi-Rad et al., 2017). Moreover, the effect of EOs on the inhibition of conidial germination is associated with a loss of membrane integrity, a decrease of cell metabolism, and accumulation of reactive oxygen species (Scariot et al., 2020).

The sensory attributes evaluated (flavor, appearance, aroma, and color) showed no statistical difference between grapes of the control and those of the EO treatment (Table 3). The average score of all samples ranged between 6 and 7 in the hedonic scale, corresponding to the items “liked it slightly” and “liked it moderately”, respectively.

Regarding the degree of differences between the control and EO-treated samples, the consumers presented the following evaluations for differences perceived between the treatments with EO: 24%, slight differences; 36%, moderate; 24%, considerable;

Table 3. Scores of sensory analysis of 'Isabella' grapes (*Vitis labrusca* × *Vitis vinifera*) treated with 1.0 µL mL⁻¹ *Eucalyptus staigeriana* essential oil⁽¹⁾.

Parameter ⁽²⁾	Control	Treatment with <i>E. staigeriana</i> essential oil
Flavor	7.31±1.62a	7.15±1.42a
Aroma	6.63±1.46a	6.52±1.59a
Appearance	6.79±1.80a	7.23±1.32a
Color	7.21±1.58a	7.62±1.21a
Parameters identified for the control sample ⁽³⁾	Treatment with <i>E. staigeriana</i> essential oil	
Feature		
Better (%)		46.00
Equal (%)		20.00
Worse (%)		34.00
Degree of difference		
None (%)		8.00
Weak (%)		24.00
Moderate (%)		36.00
High (%)		24.00
Extreme (%)		8.00
Consumption intent ⁽⁴⁾	Treatment with <i>E. staigeriana</i> essential oil	
Never		0.00
Rarely		1.40
Occasionally		2.40
Very often		4.60
Always		1.60

⁽¹⁾Means followed by equal letters, in the rows, do not differ by Tukey's test, at 5 % probability. ⁽²⁾Ten-point hedonic scale. ⁽³⁾Comparison with the control sample. ⁽⁴⁾Five-point hedonic scale.

8% extreme differences; and 8% could not perceive any difference between both samples. The consumers presented consumption intention as high, with 4.60 (on a 5-point hedonic scale) which corresponds to “very often” consumption of grapes treated with EO.

Abdollahi et al. (2012) and Frankova et al. (2016) used different EO types for the postharvest control of grape and apple diseases, respectively, and, in both studies, it was observed that the treatments with EOs showed a minimal adverse effect on their sensory profile. According to Romanazzi et al. (2012), the ideal alternative treatment for controlling postharvest diseases should be affordable and easy to implement, and should not negatively influence the fruit, the environment, or human health, and should be under food safety norms.

Conclusions

1. *Eucalyptus staigeriana* essential oil (EO) at low concentrations results in the complete inhibition of mycelial growth and conidia germination of *Colletotrichum gloeosporioides* and *Greeneria uvicola* and show fungicidal action.

2. *E. staigeriana* EO is efficient in the control of postharvest incidence of fungal rots diseases, mainly in curative treatment.

3. The OE applied on grapes shows no negative effects on the sensory properties (flavor, appearance, aroma, and color) of fruit; therefore, the consumption intention of this product is high and ranked as “very often” for grapes treated with EO.

Acknowledgments

To Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Capes, Financial Code 001), for financial support.

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