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Impact of GA_3 and spermine on postharvest quality of anthurium cut flowers (*Anthurium andraeanum*) cv. Arizona

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Highlights

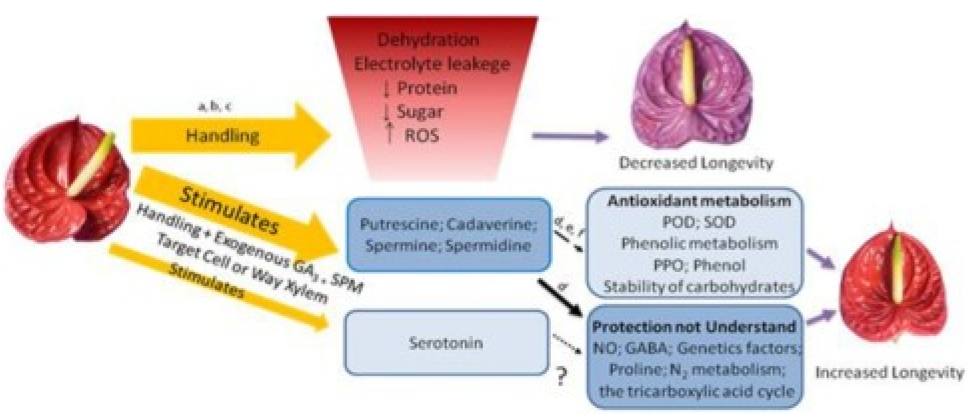
- GA_3 + SPM extended the vase life of Anthurium cut flower.
- PAs participate in non-enzymatic antioxidant defense in cut flower of Anthurium.
- Spraying with GA + SPM decreased POD and PPO activity.

- Protein and carbohydrate contents were related to commercialization quality.

Abstract

Anthurium cut flowers exposed to low temperatures may be subjected to chilling injury, whereas higher temperatures may accelerate their metabolism and induce premature senescence. Plant growth regulators, as gibberellic acid (GA_3) and spermine (SPM), have been described to extend the postharvest life of flowers. In this study, both compounds were applied by spraying or pulsing in anthurium cv. Arizona before storage at 20 °C. The solutions were constituted of 144 μM GA_3 and 2 μM SPM, which were used separately or in combination, and analyzed for 12 d. Spraying with GA_3 + SPM extended the vase life and kept the commercial quality. These treatments increase the phenols content, as well as, the activity of polyphenol oxidase (PPO), peroxidase (POD), and superoxide dismutase (SOD). Spadix sprayed with GA_3 or SPM retained high amounts of spermidine (SPD), and in the combination of GA_3 + SPM, there were higher contents of spermidine. These results suggest that the application of GA_3 + SPM by spraying can be used to reduce the senescence in anthurium cut flowers stored at 20 °C, and improve the commercial quality of the inflorescences.

Graphical abstract



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Introduction

Anthurium (*Anthurium andraeanum* L.) (Araceae) is widely used in floriculture and landscaping and its form, color, size, and spadix and spathe, determine the commercial value and are also indicators of the inflorescences quality. The cut-flowers quickly lose their commercialization characteristics, mainly due to respiratory metabolism which results from the consumption of the energetic reserves (Promyou et al., 2012).

During the senescence of flowers occurs the increase of reactive oxygen species (ROS), such as superoxide anion (O_2^-), hydrogen peroxide (H_2O_2) and hydroxyl radical (HO•). In plants, the over-production of ROS is regulated by the enzymatic (superoxide dismutase (SOD), peroxidase (POD), catalase (CAT)) and/or non-enzymatic systems (Choudhury et al., 2013). In addition, may occur an increase in the phenol levels, due to the loss of the membrane integrity, which together with the increase of the polyphenol oxidase (PPO), contribute to the spathe browning in anthurium cut flowers (Soleimani Aghdam et al., 2016a).

Anthurium cut flowers presents the vase life around 8–68 d after the harvest, according to the increase of the respiration, even with the low production of ethylene during the postharvest (Paull et al., 1992). In order to decrease the metabolic activity, one alternative is the use of low temperatures. However, these inflorescences may present chilling injury (CI) at temperatures below 12 °C (Soleimani Aghdam et al., 2016a, b), and recommended storage temperature is 12.5–20 °C (Promyou et al., 2012).

In order to increase the vase life, it is necessary to use other techniques to delay the senescence, in detrimental of low temperatures. Preservative solutions have been employed in the preservation of the cut-flowers quality. These solutions can be constituted by carbohydrates, ethylene inhibitors, growth regulators, and germicides used individually or in combination.

Plant growth regulators such as GA_3 and polyamines (PAs) have been described to extend the postharvest life of flowers (Nisar et al., 2015; Saeed et al., 2014). GA_3 is a growth regulator that has been used to extend the vase life of cut flowers. According to Emongor (2004), GA_3 is suggested to enhance the membrane stability and delays senescence in cut-flowers. Studies show that GA_3, at lower concentrations can be used to prolong the postharvest life of several flowers (Imsabai and van Doorn, 2013). GA_3 exogenous induced an increase in the SOD and POD activities in gladiolus (Saeed et al., 2014), and improve the defense systems against ROS generated during postharvest. The spraying of anthurium with 200 mg L^{-1} GA_3 extended the vase life for twenty two days (Marsala et al., 2014).

PAs such as putrescine (PUT), spermidine (SPD), and spermine (SPM), take part in many biochemical and physiological processes, including plant growth and development, mediates responses to stresses, cell division, rooting embryogenesis and development of fruit and flowers (Moschou et al., 2012; Nisar et al., 2015). Exogenous application of PAs in flowers has been verified to increase postharvest life. The vase life of *Rosa hybrida* cv. Dolce Vita increased after the application of 0.5 and 1.5 mM SPD and this increase was attributed to the highest content of proteins (Farahi et al., 2013). In *Nicotiana plumbaginifolia*, exogenous PAs (PUT, SPD and SPM) were effective antisenescence agents, retarding protein degradation and retaining the sugar contents (Nisar et al., 2015). Between the most common PAs contents, SPM is a more effective scavenger than other PUT (diamine) and SPD (triamine) (Besford et al., 1993), suggesting that there is a positive relation of the amine group in the elimination of reactive oxygen species (Kubiś, 2008). In this way, the application of SPM in anthurium cut flowers can be a form of avoiding the premature senescence by reducing the oxidative stress effect. However, application of PAs to prolong the post-harvest life of tropical flowers generates an extra cost of production and the use of low concentrations could be ideal to increase the commercial value. Due to the GA_3 action, as well as some PAs, in extending the vase life of cut flowers, our aim was to verify whether the separated or combined application of SPM and GA_3 at low concentrations can retard the senescence of anthurium cv. Arizona inflorescences. In addition, the endogenous content of PUT, SPD, and SPM were analyzed in order to establish a possible relation with the anthurium vase life.

Section snippets

Plant material and treatments

Anthurium cv. Arizona was acquired from local farmers in Recife city, Pernambuco state (8°03′14″ S latitude and 34°52′52″ W longitude) when 50% of the true flowers on the spadix had fully opened and were transported at 13 ± 2 °C in individual containers with water. After the selection, the flowers were recut in the base to maintain the pattern of 45 cm in length and placed individually in vases.

For the treatments, 240 anthuriums flowers (30 flowers per treatment) were spraying (150 mL) or…

Results and discussion

In the harvest day and 3 d after, the flowers stems were turgid, without spots, and with a bright red color, which reflects the good quality for commercialization. No visual differences were observed between control and treatments for these periods (Fig. 1A and B). The visual quality of flowers stems decreased after spraying and pulsing treatments with GA_3 or SPM, similarly to the control, from day 6 of postharvest up to day 12 (Fig. 1A and B). These results showed that GA_3 or SPM, independent…

Conclusion

The treatment with 144 μM GA_3 + 2 μM SPM by spray were efficient to extend the vase life of anthurium cv. Arizona cut flowers stored at 20 °C. In addition, GA_3 and SPM treatment was efficient to maintain the levels of carbohydrates. The flowers treated with the GA_3 and SPM combination promoting increase in the activity of enzymes such as PPO, POD, and SOD; however, with lower activities compared to the other treatments. GA_3 + SPM stimulated endogenous accumulations of spermidine, spermine,…

Acknowledgements

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> *Citation Excerpt :*
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> …MT treatments delayed carnation polyphenol degradation and 0.1 mM MT treatment maintained TPC content for a longer period. Similarly, higher phenolic concentrations were observed in different cut flower species, such as anthurium, gladiolus and gerbera, after GABA, polyamines or GA3 treatments as well as an extension in their vase life (Aghdam et al., 2015; Sajjad et al., 2015; do Nascimento Simões et al., 2018; Mohammadi et al., 2020). The higher TPC in MT treated flowers could be attributed to a reduction in the PPO activity and to an increase in antioxidant activity as has been described in cut anthurium flowers by Aghdam et al. (2019).…

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2019, Postharvest Biology and Technology

> *Citation Excerpt :*
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> …Low temperature storage may be used to prolong the storage life of cut anthurium flowers, but storage is limited by chilling injury, which is manifested as spathe browning (Paull and Chantrachit, 2001;

Aghdam et al., 2015; Liang et al., 2018; Promyou et al., 2012). Possible strategies to extend storage life of cut anthurium flowers that have been investigated include the application of salicylic acid (Aghdam et al., 2016a, d; Promyou et al., 2012), γ-aminobutyric acid (GABA) (Aghdam et al., 2016b, c; Aghdam et al., 2015), gibberellic acid and spermine (do Nascimento Simões et al., 2018), nitric oxide (Liang et al., 2018), calcium chloride (Ketrodsakul et al., 2016), and cytokinin (Whittaker et al., 1992). Melatonin can confer chilling and fungal decay tolerance, delay senescence, and preserve marketing quality in horticultural crops (Aghdam and Fard, 2017; Aghdam et al., 2019)....