Effect of preservative solutions on postharvest of *Eustoma Grandiflorum* floral stems during refrigerated storage

Efeito das soluções conservativas na pós-colheita de hastes florais de *Eustoma Grandiflorum* durante o armazenamento refrigerado

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**ABSTRACT**  
Preservative solutions contribute to flowers post-harvest quality and longevity, having different effects according to the species, cultivar, cold storage period and the solution composition. This work aimed to determine the preservative solution more effective on opening flower and longevity on flower cut stems of *E. grandiflorum*, submitted to two cold storage periods. The experiment was arranged in a 2x4x10 factorial, with two storage periods, five and ten days; four preservative solutions, water (100%); sodium hypochlorite (25 ml L\(^{-1}\)) + sucrose (10%); aluminum sulfate (250 mg L\(^{-1}\)) + sucrose
(10%); and silver nitrate (50 mg L\(^{-1}\)) + sucrose (10%); and ten evaluation dates. Cut stems from the cultivar ‘White Excalibur’ were placed taken to cold storage for 5 and 10 days at 5°C and 78% of relative humidity. After cold storage, the stems were distributed to glass pots containing different preservative solutions. Every two days, visual evaluations were performed, verifying the opening flower and longevity. An illustrative scale were used to assess the opening of flowers buds, with grades ranging from 1 to 5. For the longevity, the number of days that flowers remained viable in the preservative solutions until the disposal was considered. The cold storage periods do not affect opening flower and longevity of ‘White Excalibur’ floral stems. Silver nitrate + sucrose and aluminum sulfate + sucrose were the preservative solutions that provides better post-harvest quality and longevity, with higher opening flowers and extended viability.

**Keywords:** lisianthus, opening flower, flowering, longevity.

**RESUMO**

As soluções conservantes contribuem para a qualidade de pós-colheita e longevidade das flores, tendo efeitos diferentes de acordo com a espécie, cultivar, período de armazenamento a frio e composição da solução. Este trabalho teve como objetivo determinar a solução conservante mais eficaz na abertura da flor e na longevidade de hastes cortadas de *E. grandiflorum*, submetidas a dois períodos de armazenamento a frio. O experimento foi organizado em fatorial 2x4x10, com dois periodos de armazenamento (cinco e dez dias), quatro soluções conservantes, água (100%); hipoclorito de sódio (25 ml L\(^{-1}\)) + sacarose (10%); sulfato de alumínio (250 mg L\(^{-1}\)) + sacarose (10%); e nitrato de prata (50 mg L\(^{-1}\)) + sacarose (10%) e dez datas de avaliação. As hastes cortadas da cultivar ‘White Excalibur’ foram levadas ao armazenamento a frio por 5 e 10 dias a 5°C e 78% de umidade relativa. Após o armazenamento a frio, as hastes foram distribuídas em recipientes de vidro contendo diferentes soluções conservantes. A cada dois dias, foram realizadas avaliações visuais, verificando a abertura das flores e a longevidade. Uma escala ilustrativa foi usada para avaliar a abertura dos botões florais, com notas variando de 1 a 5. Quanto à longevidade, foi considerado o número de dias em que as flores permaneceram viáveis nas soluções conservantes até o descarte. Os períodos de armazenamento a frio não afetam a abertura das flores e a longevidade das hastes florais ‘White Excalibur’. Nitrato de prata + sacarose e sulfato de alumínio + sacarose foram as soluções conservantes que proporcionaram melhor qualidade pós-colheita e longevidade, com maior abertura das flores e viabilidade prolongada.

**Palavras-chave:** lisianthus, abertura de flores, florescimento, longevidade.

**1 INTRODUCTION**

The production of cut flowers is a very promising activity in Brazil, due to its productive and economic potential. However, the flowers commercialization demand for adequate conservation techniques to ensure the quality and extend postharvest durability (SCHMITT, 2014).

The floral stems durability is affected by several factors, inherent in the plant or growing and postharvest conditions, such as water losses, pathogens occurrence and...
ethylene synthesis (DA COSTA et al., 2021; KHUNMUANG et al., 2019). Quality losses in postharvest stem from inadequate handling and transportation, deterioration by microorganisms, inappropriate package and commercialization structure (DIAZ et al., 2017). In this sense, the adequate flowers storage in conditions of temperature and humidity controlled, is a good way to delay deterioration, since reduces flowers metabolism (CAVASINI, 2013).

=E. grandiflorum= is a flower for cutting that has been expanding and is among the most popular cut flowers (SKUTNIK et al., 2021). The species presents a good postharvest durability can reach up to 15 days when stems are properly handled (BRAGANÇA, 2021; KAINAT et al., 2022). Therefore, proper refrigeration is fundamental in keeping postharvest quality (FAVERO AND DIAS., 2021). After cold storage, other conservation methods can improve the flowers durability, especially when provided with floral preservatives (CHUANG; CHANG, 2013). These products preserve the quality and extending the vase life and the viability of flowers cut (MATAK et al., 2017; MAZROU et al., 2022), through energy substrate supply, hydration of tissues and antimicrobial action (DE PIETRO, 2009).

The sucrose improves floral stems quality, by promoting bud flowers opening, what also extend the cuts viability; but its isolated utilization promotes microorganism’s proliferation, then reducing the longevity of floral stems. Therefore, to reduce this problem, other products with antibacterial and germicide action are added to the preservative solution, such as silver nitrate, aluminum sulfate and sodium hypochlorite. However, information about the use of these products in =E. grandiflorum= postharvest conservation is incipient; and its effect may differ among the concentrations and kind of products added to the solution, besides the response of different cultivars (SALES et al., 2021; ALMEIDA et al., 2011).

In this regard, this work aimed to determine the most adequate preservative solution for =E. grandiflorum= stems quality and longevity, submitted to two cold storage periods.

2 MATERIAL AND METHODS

The trial was performed in Pelotas-RS, Brazil. The latitude is 31° 46’ S, longitude 52° 20’ O, and altitude of 60 meters.

Stems from “White Excalibur” cultivar were harvested in the morning, and the leaves from the lower third were removed. After that, the stems were stored in water
buckets inside cold storage, at 5°C, for the periods of five and ten days. After cold storage, the stems were standardized with same length, only one open flower per stem and five buds with ornamental potential and distributed to glass pots containing the different preservative solutions.

The preservative solution tested were water (100%); sodium hypochlorite (25 ml L\(^{-1}\)) + sucrose (10%) (SH+S); aluminum sulfate (250 mg L\(^{-1}\)) + sucrose (10%) (AS+S); and silver nitrate (50 mg L\(^{-1}\)) + sucrose (10%) (SN+S).

The experimental design was completely randomized, with three repetitions, in a 2x4x10 factorial arrangement, with two storage periods, five and ten days; four preservative solutions, water, SH+S, AS+S and SN+S; and ten evaluation dates. Each repetition was composed by one plot containing 1 L of preservative solution and one stem.

Every two days, visual evaluations were performed, verifying the opening flower and longevity, followed by the replacement of respective preservative solutions. The last centimeter of stems base was cut off. An illustrative scale were used to assess the opening of flowers buds, with grades ranging from 1 to 5 (Figure 1).

Figure 1: Grades for the opening flowers stages: closed bud, with green colour, sepals at 90°, added to petals (1); buds beginning to change its colour, sepals added to petals (2); white colour bud, sepals at 45°, separated from petals (3); flowers starting opening, pistils and stamens not visible (4); completely opened flower, pistils and stamens visible (5).

Source: Adapted from Alves, 2012.

The average grade was calculated for each stem, considering all the non-senescent flowers. For the longevity, it was considered the number of days that flowers remained viable in the preservative solutions until the disposal, when flowers become with not suitable aspect to be used (old and withered flowers and leaves).

Data obtained by grades were processed to square root, and then used to perform variance analysis. The averages were compared by Tukey’s test, at a 5% probability. The charts were performed by Errors-Bar Charts procedure.
3 RESULTS AND DISCUSSION

The variance analysis did not show significance for the interactions storage period x preservative solution x evaluation date, neither for storage period x preservative solution. There was significance for the factors storage period x evaluation date, and for the preservative solution x evaluation date.

Regarding to the character opening flowers, the two cold storage periods (5 and 10 days of storage) presented differences in the first evaluation date (Figure 2). From this date forward, the cold storage did not had more influence on the opening of flower buds. The most of opening flowers occurred at the sixth evaluation date, without difference from day 0 to 10th for stems in 10 days of storage cold. For the stems in 5 days of storage cold, the number of opening flowers raised gradually to the eighth evaluation date, without difference among the forth and the tenth evaluation date. The number of opening flowers gradually reduced, for the both storage periods (5 and 10 days), from the twelfth evaluation date in relation to the greatest opening flower observed.

Then, the storage period did not influence the postharvest quality of *E. grandiflorum* stems, and the longest cold storage period (10 days) did not reduce its quality, just provided higher opening flowers. In this way, stems kept in preservative...
solutions after removed from cold storage (5 or 10 days) only differ at the first evaluation date (day 0), when the higher number of opening flowers was observed in a period of ten days. Probably the opening of flower buds occurred even before the stems were placed in the preservative solutions, in the cold storage.

Flowers longevity is a very important commercial character, since represents the time that flowers remain viable for selling, and higher viability for be used by the consumer (ZHAO et al. 2020).

Overall, flowers species and cultivars react differently to low temperatures and periods of storage. DURIGAN (2009), evaluating temperature effects and the preservative solution replacement on the postharvest quality of three Gerbera L. cultivars, observed that cold storage at 8°C and 12°C provided higher longevity to the ‘Red Amy’ and ‘Pink Star’ cultivars, but prejudiced the cultivar ‘Contour’. The same work showed that higher longevity, of 16 days, was achieved by cultivar ‘Pink Star’, with previous storage at 8°C. This shows that temperature is a critical environmental factor in horticultural products storage, because directly affect respiration, transpiration besides other biochemistry and physiological aspects during postharvest period. Therefore, postharvest techniques and technologies make continuous efforts to regulate senescence factors, improve the quality of cut flowers, and prolong their shelf life (DA COSTA et al. 2021).

Even though this work did not show differences among the two scold storage periods, this procedure is considered effective to maintain and extend postharvest quality of potted flowers for 10 days, in average.

In environmental temperature, flowers durability is usually short, differing according to the species or cultivar. Flower stems of when calla lily harvested with open spathe and with the tip still facing upwards stored in a cold chamber, the shelf life is 7 days, whereas if kept at room temperature (20 ºC), the shelf life period is reduced to 4 days (CASTRO et al. 2014).

With respect to the effect of preservative solutions, the higher opening flower of stems stored in silver nitrate sucrose solution (SN+S) occurred at the eighth evaluation date (Figure 3).
However, stems stored in water did not differ among cold storage periods until the tenth evaluation date, when they were disposed. This same behavior was observed for the sodium hypochlorite + sucrose solution (SH+S) until the twelfth evaluation date, disposing the stems at fourteenth day due to the high flowers senescence. Stems storage in aluminum sulfate + sucrose solution (AS+S) did not present differences until sixteenth evaluation date, with reduction of flowers number at the eighteenth day. For the stems stored in SN+S solution, the higher opening flower occurred between twelfth and sixteenth evaluation date, with superior difference among day 0 and eighteenth day.

The main effect of the preservative solution was on stems longevity. The AS+S and SN+S solutions preserved stems quality for up to 18 days, while stems storage in water and SH+S solution achieved 10 and 12 days, respectively. The water as component of preservative solution has the purpose of hydrated the stems, which ones rapidly lost turgidity after harvested.

Considering the effect of all the preservative solutions, excepting water, on the *E. grandiflorum* postharvest quality, the AS+S and SN+S solutions are more appropriate to extend stems longevity. The greater effectiveness of these preservative solutions may be due to their composition. Silver nitrate (SN+S) contain Ag+ ion, which one block ethylene synthesis, delaying flowers senescence and abscission. The AS+S solution
presents acidifying function, that control microorganisms development, and favor water absorption by stems.

The SH+S solution was not effective on *E. grandiflorum* preservation, because, possibly, the presence of sodium or chlorine caused phytotoxicity. Small spots were identified in the lower part of stems, what indicate such effect. These stems lost commercial standard, according to the evaluation criterion, at the ninth day, similarly to stems storage in water. In this sense, an alternative to be tested is a lower concentration of sodium hypochlorite, around 2%, to obtain better results on *E. grandiflorum* postharvest longevity.

4 CONCLUSIONS

The period of cold storage do not affect opening flowers and longevity of *E. grandiflorum* cut stems.

The preservative solutions silver nitrate + sucrose and aluminum sulfate + sucrose provide better quality and conservation of *E. grandiflorum*, with more opened flowers and longevity of floral cut stems.
REFERENCES


