

## Post harvest of pink ginger floral stems treated with silver thiosulphate, sucrose, and calcium

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### ABSTRACT

The Brazilian market of tropical flowers has been growing broadly with a strong participation of the Northeast Region, where the State of Alagoas stands out. Among the exporting tropical cut flowers, pink ginger (*Alpinia purpurata* (Vieill) K. Schum) has been one of the most promising species. Aiming at delaying senescence in floral stems of pink ginger, two laboratory experiments were carried out at the Agricultural Science Center of the Federal University of Alagoas. In the first experiment, three different exposure periods (30; 60, and 120 minutes) to silver thiosulphate 1 mM were tested, followed or not by pulsing in a 20% sucrose solution, for 12 hours. In the second experiment, we evaluated the effect of adding calcium sulphate 50 and 100 mM, sodium silicate 1.25 and 2.5 mM, and the combination of calcium sulphate 50mM + sodium silicate 1.25mM on the hydric status and longevity of floral stems. In both experiments, the control treatment consisted of keeping stems in distilled water. Fresh biomass and quality of floral stems were determined every other day. Silver thiosulphate applied in pulsing for 60 minutes or more led to stem dehydration, whereas calcium sulphate improved both stem hydration and commercial durability.

**Keywords:** *Alpinia purpurata*, tropical flowers, commercial durability, cut flower, vase life.

### RESUMO

#### Pós-colheita de hastes de alpinia tratadas com tiosulfato de prata, sacarose e cálcio

O mercado brasileiro de flores tropicais encontra-se em franco crescimento, com uma importante participação da região Nordeste, destacando-se o estado de Alagoas. Dentre as flores tropicais de corte para exportação, a alpinia (*Alpinia purpurata* (Vieill) K. Schum) ocupa posição de destaque. Visando retardar a senescência das hastes florais de alpinia, cultivar Pink Ginger, foram conduzidos dois experimentos em laboratório no CCA da Universidade Federal de Alagoas. No primeiro, foram testados três tempos (30; 60 e 120 minutos) de exposição ao tiosulfato de prata 1 mM, seguido ou não de *pulsing* em sacarose a 20%, por 12 horas. No segundo experimento foram verificados os efeitos nas relações hídricas e longevidade das hastes da adição de sulfato de cálcio a 50 e 100 mM, silicato de sódio a 1,25 e 2,50 mM, além da interação sulfato de cálcio a 50 mM + silicato de sódio a 1,25 mM, em solução de manutenção. Nos dois experimentos, a testemunha consistiu da manutenção das hastes em água destilada. A massa fresca e a qualidade das hastes foram determinadas a cada dois dias. O tiosulfato de prata, aplicado na forma de *pulsing* por 60 minutos ou mais, promoveu desidratação das hastes. O uso de sulfato de cálcio promoveu aumento da durabilidade comercial e melhoria da hidratação das hastes.

**Palavras-chave:** *Alpinia purpurata*, flores tropicais, durabilidade comercial, flor de corte, vida de vaso.

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*Alpinia purpurata* (Vieill) K. Schum. (Zingiberaceae) is an ornamental plant also used as a cut flower (Luz *et al.*, 2005). Known as pink ginger, the plant originated from the forests and fields of New Caledonia, Salomon, and Virgin Islands, and Bismarck and Bougainville archipelagos (Wagner *et al.*, 1999). Nowadays, the pink ginger can be found in different tropical regions around the world. It is ranked as the second most important tropical cut flower species in economic terms within the world market (Castán-Bañeras, 1997), as well as among the tropical flowers exported by the State of Alagoas.

The excessive loss of water by transpiration is one of the reasons for post harvest senescence (Paiva *et al.*, 2005). High level of tissue hydration is usually associated to the increase of vase life in cut flowers, whereas fresh weight losses of 10 to 15% can cause tissue death (Moraes *et al.*, 1999). The supply of different types of sugar, mainly sucrose, in conditioning or maintenance solutions, besides replacing the carbohydrates consumed by respiration, promotes reduction in transpiration, once it induces the closing of stomata (Halevy & Mayak, 1981).

The wilting and senescence of cut

flowers are influenced by ethylene (Finger *et al.*, 1999). The silver ion is a competitive inhibitor, which reduces the binding of ethylene to its receptor (Cook & Standen, 1987), preventing the hormone from acting and, consequently, increasing the longevity of cut flowers. The main use of silver in flower post harvest is as silver thiosulphate (STS). In red ginger, STS was tested by Broschat & Donselman (1988), Reid (1989), and Mattiuz (2003). In all cases, phytotoxic effects were observed. However, once concentration and exposure time are important elements (Faragher *et al.*, 2002), it is necessary to have these

aspects tested, particularly for pink ginger.

Savvas *et al.* (2002) noticed that silicon (Si) in hydroponic solution improved stem quality in *Gerbera jamesonii* Bollus. Its use in postharvest demands investigation, once it reduces transpiration and increases xylem resistance to compression (Salisbury & Ross, 1994). On the other hand, calcium, which has been broadly tested in fruit postharvest, started to be studied in flowers as well, with excellent results in roses (Torre *et al.*, 1999; Capdeville *et al.*, 2003, 2005).

The objective of this study was to test STS effects, followed or not by sucrose pulsing, as well as calcium and silicon use in the maintenance solution on the hydric status, and vase life of *Alpinia purpurata* var. Pink Ginger.

## MATERIAL AND METHODS

This study consisted of two experiments carried out at the Laboratory of Vegetal Physiology from the CCA of the Universidade Federal de Alagoas, from June to August, 2005. Floral stems came from a commercial garden in the City of Rio Largo, Alagoas State. The two harvests were carried out by 7h00 am. It took approximately 40 minutes to have the stems cut, prepared, and transported to the lab.

Harvested stems, having 20-cm long inflorescences and 2/3 of their expanded bracts, were standardized (90 cm long, from the flower stem base to the inflorescence top), disinfested for 5 min in tanks filled with a solution of diazenon, decis and mineral oil in a proportion of 1 mL/L, rinsed in running water, and taken to the lab. Before setting up each experiment, stems were weighed in digital scales to determine initial fresh weight.

In the first experiment, stems were immersed in a silver thiosulphate solution (STS) 1 mM for 30; 60; or 120 minutes, followed or not by pulsing in a sucrose solution 20% for 12 h. Next, stems were transferred to recipients with distilled water where they were kept until the end of the experiment. In the second experiment, stems were kept in

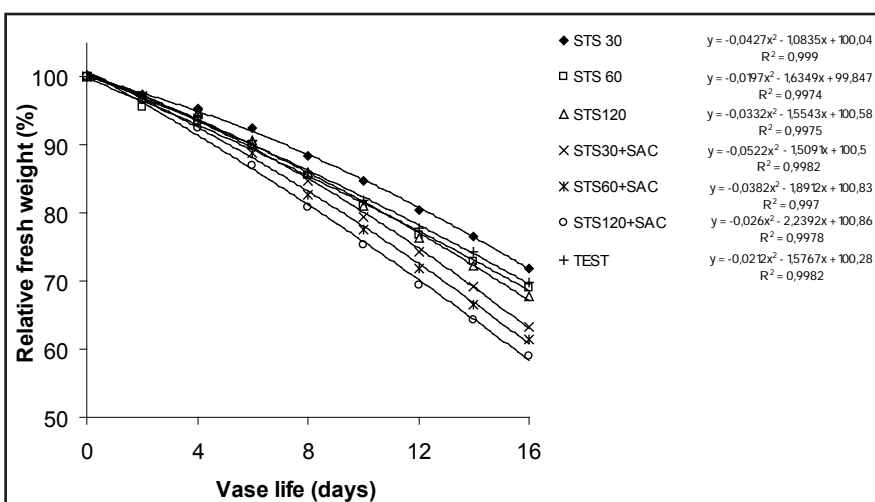
solutions of calcium sulphate (50 and 100 mM), or sodium silicate (1,25 and 2,5 mM), or in calcium sulphate 50 mM + sodium silicate 1,25 mM. The first and second experiments summed up respectively seven and six treatments. Both experiments were carried out with four three-stem replications. The control treatment corresponded to stems kept in distilled water during the whole period.

In both experiments, stems were weighed and had their quality evaluated every other day. Three different evaluators graded stems according to the following criteria: (adapted from Tagliacozzo *et al.*, 2003): 4= excellent (turgid and bright bracts); 3= good (start of turgor loss, only perceptible by touch); 2= moderate (visible turgor loss, stems bending up to 45°, leaf roll); 1= severe (severe turgor loss, stems bending more than 45°, most of leaves yellow and/or dry); and 0= very severe (flower stem totally dry). Simultaneously, stems were weighed to estimate the variation in fresh matter. The commercial durability was set as the number of days from harvest until stems reached an average grade of 2.7 (according to Tagliacozzo *et al.*, 2003), while total longevity corresponded to the number of days from harvest to complete stem senescence (score 0).

Throughout the experiments, lab temperature was 24±1°C, relative humidity 57±2%, and light intensity 23,12 µmol m<sup>-2</sup>s<sup>-1</sup>. The experiments were carried out in a completely randomized design. Data were submitted to analyses of variance and F test. Means were compared using the Tukey test, at 5% probability. Data corresponding to the fresh weight loss of floral stems during the period of longevity evaluation were submitted to analyses of regression.

## RESULTS AND DISCUSSION

Stems pre treated with STS for 30 minutes and kept in distilled water presented the largest fresh weight throughout the experiment (Figure 1), which indicates that this treatment helped in preserving stem hydration. Nevertheless, there was no statistically significant effect of STS over the commercial durability and total longevity of stems when compared to the control (Table 1). Fresh weight loss was higher in stems submitted to STS + sucrose, showing that sucrose pulsing after the exposure to STS was harmful to stems. Symptoms of hydric deficiency, such as leaf roll, inflorescence bending, and dry up of bracts from the edges to the center, were occasionally observed, mostly in treatments with STS for 120

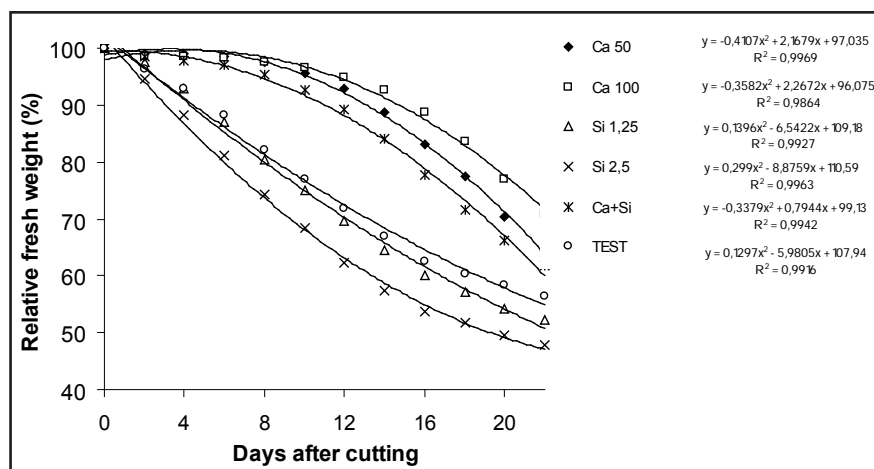


**Figure 1.** Relative fresh weight of Pink Ginger stems submitted to silver thiosulphate (STS) 1mM, for 30; 60; and 120 minutes, followed or not by pulsing of sucrose 20% for 12 hours (massa fresca relativa de hastes de alpinia submetidas a solução de tiossulfato de prata (STS) a 1mM, por 30; 60 e 120 minutos, seguidas ou não de pulsing de sacarose, a 20%, por 12 horas). Rio Largo, UFAL, 2009.

**Table 1.** Commercial durability and total longevity of Pink Ginger stems submitted to silver thiosulphate 1mM, for 30; 60, and 120 minutes, followed or not by a pulsing of saccharose 20% for 12 hours (durabilidade comercial e longevidade total de hastes de alpinia submetidas à solução de tiosulfato de prata a 1mM, por 30; 60 e 120 minutos, seguido ou não de exposição a pulsing de sacarose a 20%, por 12 horas). Rio Largo, UFAL, 2009.

Treatments	Commercial durability (days)	Total longevity (days)
STS <sup>1</sup> for 30 min	8,2 A	16,0 A
STS <sup>1</sup> for 60 min	6,5 A	15,5 AB
STS <sup>1</sup> for 120 min	6,0 A	15,0 AB
STS <sup>1</sup> for 30 min + sucrose for 12 h	5,5 A	15,0 AB
STS <sup>1</sup> for 60 min + sucrose for 12 h	5,0 A	16,0 A
STS <sup>1</sup> for 120 min + sucrose for 12 h	4,7 A	12,5 B
Control	6,2 A	15,5 A
<b>CV %</b>	<b>35,8</b>	<b>9,3</b>

Means followed by the same letter in the column do not differ significantly from each other, Tukey test, p<0.05 (médias seguidas de mesma letra na coluna não diferem significativamente entre si, Teste de Tukey, p<0,05); <sup>1</sup>STS= silver thiosulphate (tiosulfato de prata).



**Figure 2.** Relative fresh weight of Pink Ginger stems kept in different vase solutions, containing calcium sulphate 50 and 100 mM, sodium 1,25 and 2,5 mM, and calcium sulphate 50 mM + sodium silicate 1,25 mM (massa fresca relativa de hastes de alpinia mantidas em diferentes soluções de manutenção, contendo sulfato de cálcio a 50 e 100 mM, silicato de sódio a 1,25 e 2,5 mM e sulfato de cálcio a 50 mM + silicato de sódio a 1,25 mM). Rio Largo, UFAL, 2009.

minutes + sucrose for 12 h. In addition, leaf whitening, which is typical of STS phytotoxicity (Faragher *et al.*, 2002), was also present. In *Alpinia purpurata*, cultivar Red Ginger, Broschat & Donselman (1988), and Mattiuz (2003) found phytotoxic effects when STS 2 mM and 1 mM were applied with pulsing for 4 and 6 hours respectively. The results gathered in the present study suggest that STS 1 mM for 30 minutes approached the limit between the sought benefit and the toxic effect,

which points to the need to test either the same concentration for shorter periods of time or less concentrate STS solutions for the same period.

In other species, synergistic results were obtained by the use of sucrose + STS, as observed in flowers of *Lathyrus odoratus* L. (Ichimura & Hiraia, 1999) and *Rosa hybrida* L. (Liao *et al.*, 2000). However, Broschat & Donselman (1988) did not notice similar results in Red Ginger with STS 2 mM pulsing for 4 hours, followed by placing stems

in a vase solution with sucrose 2% + citrate of hydroxyquinoline 200 ppm or in deionized water. In both cases, a drastic reduction in the post harvest life due to the phytotoxic effects was observed. Likewise, Finger *et al.* (2004), after working with *Consolida ajacis* Nieuw, noticed that stems treated only with STS 1mM for 30 minutes had a larger longevity than those treated with STS 1 mM + sucrose 5% for 30 minutes, which, according to the authors, was due to the autocatalytic stimulation of the ethylene by sucrose.

In the second experiment, treatments using calcium sulphate improved stem hydration and preserved the stem fresh weight up to the eighth day (Figure 2). On contrary, the hydration level in treatments with sodium silicate was below those observed in the control. Calcium sulphate significantly extended both the commercial durability and the total longevity of stems (Table 2). Sodium silicate results, when used alone, independent of the concentration, were similar or worse than those of the control. The use of calcium sulphate + sodium silicate did not differ significantly from treatments in which only calcium sulphate was employed.

Calcium sulphate positive effects can be credited to the ion calcium, once this element has presented remarkable effects in stomata closure, a mechanism that regulates water stress (Yang *et al.*, 2003; Taiz & Zeiger, 2004). Furthermore, high concentrations of calcium in vegetal tissues reduce both the ethylene production and the transpiration level. Calcium role is comparable to AVG's (aminoethoxy vinyl glycine, an inhibitor of the enzyme ACC sintase), inhibiting the ethylene synthesis, and also similar to cytokinines<sup>2</sup> in suppressing respiration, which suggests that calcium may have a role as a hormone regulator in senescent tissues (Fernandes, 2002). In Pink Ginger, ion Ca<sup>2+</sup> behaved as a senescence delayer in vase life, probably by regulating the water stress, as well as preserving membrane functions and structure (Halevy *et al.*, 2001), or making the cellular walls less accessible to the action of hydrolytic enzymes (Poovaiah *et al.*, 1988).

In addition to calcium, we could

**Table 2.** Commercial durability and total longevity of Pink Ginger stems kept in different vase solutions, containing calcium sulphate and/or sodium silicate (durabilidade comercial e longevidade total de hastes de alpinia mantidas em diferentes soluções de manutenção contendo sulfato de cálcio e/ou silicato de sódio). Rio Largo, UFAL, 2009.

Treatments	Commercial durability	Total longevity
	(days)	(days)
Ca 100 mM	15,2 A	21,0 A
Ca 50 mM	13,7 A	21,5 A
Si 1,25 mM	5,5 B	14,5 B
Si 2,5 mM	3,5 B	11,0 B
Ca 50 mM + Si 1,25 mM	13,5 A	21,0 A
Control	5,5 B	14,5 B
<b>CV (%)</b>	<b>21,3</b>	<b>10,7</b>

Means followed by the same letter in the column do not differ significantly from each other, Tukey test,  $p < 0.05$  (médias seguidas de mesma letra na coluna não diferem significativamente entre si, Teste de Tukey,  $p < 0,05$ ).

have attributed some importance to sulphur as well. Nevertheless, it should be highlighted that sulphate ( $\text{SO}_4^{2-}$ ) is reduced by assimilation and that sulphate is the final product of this reaction. Sulphate does not accumulate in the cells and is quickly reduced to amino acids cysteine and methionine. The later compound is ethylene precursor (Taiz & Zeiger, 2004).

Silicon was expected to present better results, especially regarding the stem hydric balance. Silicon reduces plant transpiration and increases xylem resistance to compression (Salisbury & Ross, 1994), which decreases plant water demand (Korndörfer & Pereira, 2001). However, this has not been confirmed. On contrary, it was observed that sodium silicate had deleterious effects, possibly due to the presence of sodium.

Sucrose and STS in the studied concentrations did not increase stem longevity, although it is suggested that tests with STS in lower concentrations should be carried out. Calcium sulphate had promising results regarding flower stem longevity in Pink Ginger. As far as we know, the results reported here in the use of calcium to extend vase life on tropical cut flowers are the first ever, and open a range of opportunities for future research using calcium solutions.

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