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Chlorine Dioxide Reduces Bacteria and Increases Vase Life of Fresh Cut Flowers

A.J. Macnish, Postdoctoral Researcher, T.A. Nell, Professor and Chairman,
R.T. Leonard, Biological Scientist, and A.M. Alexander, Biological Scientist
Department of Environmental Horticulture, University of Florida, Gainesville, 32611

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Phone: 703/838-5211
Fax: 703/838-5212
E-mail: afe@endowment.org
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BACKGROUND

Cut flower longevity is often reduced by an accumulation of bacteria in floral solutions and flower stems. Chlorine dioxide (ClO_2), a broad spectrum bactericide commercially used for sanitizing fruit and vegetable surfaces, was tested to determine its potential use as an antimicrobial agent for fresh cut flower stems and solutions.

MATERIALS AND METHODS

Flowering stems of Alstroemeria, Snapdragon, Delphinium, Carnation, Chrysanthemum, Gerbera, Gypsophila, Asiatic Lilies, Stock, and Roses were obtained from production areas in California or Colombia and commercially transported to the University of Florida postharvest laboratory within 2 to 7 days after harvest.

Various concentrations of ClO_2 used for treatments were prepared by diluting a 500 ppm stock ClO_2 solution (Selectrocide™ 2L500; Selective Micro Technologies, LLC, Beverly, MA, USA) in deionized water. In the first study, stems were held in ClO_2 concentrations of 0, 2, 5, 10, 20 and 50 ppm to determine the optimum effectiveness of the product.

A second study evaluated the effectiveness of adding 10 ppm ClO_2 to vase solutions with known concentrations of bacteria previously isolated from vase water from each flower species. In addition, we tested the effectiveness of a farm-level ClO_2 hydration and stem dips (10 ppm for 1 minute) and the efficacy of ClO_2 vase water treatments compared to other biocides. Vase life and quality of all studies were evaluated at 70 °F, 70 ftc (12 hrs/day) and 50% relative humidity.

RESULTS

A 2 ppm concentration of aqueous ClO_2 was optimal for extending vase life of Stock, while 10 ppm of aqueous ClO_2 was most effective for prolonging vase life of the other responsive flower species. The highest concentration of 50 ppm reduced vase life for Delphinium and Chrysanthemum and accelerated leaf chlorosis on Alstroemeria and Lilies.

Adding low concentrations (2 to 10 ppm) of aqueous ClO_2 to deionized vase water significantly extended the display life of Alstroemeria, Snapdragon, Carnation, Gerbera, Gypsophila, Asiatic Lilies, Stock, and Roses (Photo 1). Vase life increased by 0.9–13.4 days (7–77%) compared to flowers not held in ClO_2.

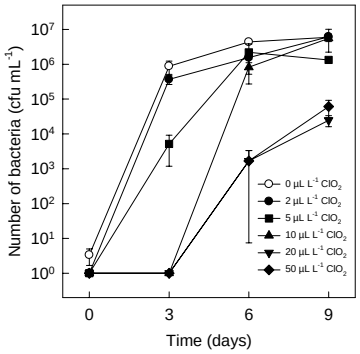
Photo 1. Examples of increased vase life of Alstroemeria (left) and Snapdragons (right) when held in 10 ppm ClO_2.

Control ClO_2 Control ClO_2

ClO_2 treatment prolonged vase life in association with a delay in the onset of bacterial colonization in vase water. Concentrations of 2 and 5 ppm ClO_2 significantly reduced bacteria for 3 days, while higher concentrations

delayed bacterial growth longer (Fig. 1).

Fig. 1. Number of bacteria in Gerbera vase water treated with various ClO_2 concentrations.



Adding 10 ppm ClO_2 to vase water inoculated with bacteria (10^{11} CFU L^{-1}) reduced or eliminated the loss in vase life in 5 out of 10 species tested (Snapdragon, Chrysanthemum, Gypsophila, Stock and Roses) compared to vases inoculated without ClO_2. An increase in water uptake rates and decreased rates of fresh weight loss were also observed when inoculated vases were treated with ClO_2.

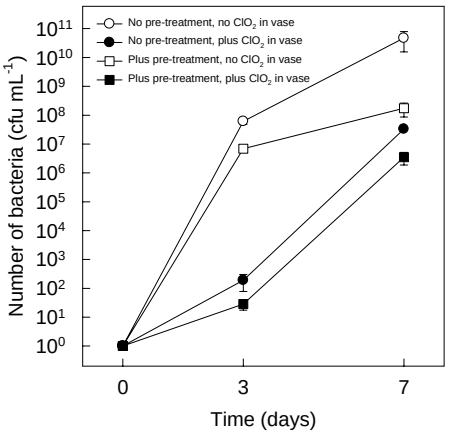
Hydrating Gerbera 'Tsar' stems immediately after harvest for 72 hours at 40 °F with 10 ppm ClO_2 extended vase life by 2.6 days. Combining this treatment with a prior 1 minute 10 ppm ClO_2 stem dip, increased vase life 4.2 days compared to flowers with no ClO_2 pre-treatments (Table 1). These combined pre-treatments also prevented bacteria growth in post-shipment hydration water.

Table 1. Vase life of Gerbera 'Tsar' pretreated with and without chlorine dioxide.

Pre-treatment dip	Hydration treatment	Vase life (days)
No dip	- ClO_2	4.4 a
	+ ClO_2	7.0 b
+ ClO_2	- ClO_2	8.4 c
	+ ClO_2	8.6 c

A one minute dip of mixed bouquet stems in 10 ppm ClO_2 significantly reduced the number of bacteria that colonized vase water, especially when held afterward in 10 ppm ClO_2 (Fig. 2). Including ClO_2 in the vase water after the dip increased vase life 17 to 56% compared to control flowers.

Fig. 2. Chlorine dioxide reduced vase water bacteria of mixed bouquets.



In comparison to other antimicrobial agents, ClO_2 and 8-hydroxyquinoline sulfate (8-HQS) were more effective in extending the vase life of Gerbera 'Julia', 'Lorka' and 'Vilassar' flowers than other tested biocides (i.e. aluminum sulfate, DICA, Physan 20^{TM}, sodium hypochlorite) when included in vase water containing 0.2 g L^{-1} citric acid and 10 g L^{-1} sucrose (Photo 1).

Photo 1. Chlorine dioxide prolonged vase life of Gerbera 'Lorka' by 2.3 days.

Control ClO_2

CONCLUSIONS

Chlorine dioxide was very effective in reducing bacteria in solutions, increasing vase life from 7 to 77% in 8 of 10 flower species tested, showed similar levels of efficacy to 8-HQS, and was more effective than all other tested biocides.

IMPACT TO THE INDUSTRY

ClO_2 is an effective treatment for controlling bacteria in vase solutions and extending cut flower longevity of many popular fresh cut flower species.

Contact:
tanell@ufl.edu