Available online at www.worldscientificnews.com

World Scientific News

WSN 69 (2017) 239-243 EISSN 2392-2192

SHORT COMMUNICATION

Effects of colloidal silver on vase life of cut chrysanthemum

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ABSTRACT

In this study, the efficacy of colloidal silver in extending the vase life of cut chrysanthemum 'Feeling Green' inflorescences was evaluated. Three concentrations of colloidal silver were used: 0.01%, 0.02 % and 0.04%. Control inflorescences were kept in water. Colloidal silver treatments at all concentrations extended the vase life of cut chrysanthemum. The 0.02% colloidal silver treatment produced the longest vase life (25 days), while the control resulted in the shortest vase life (18 days). In addition, the less weight loss were observed in the inflorescences exposed to the solution of colloidal silver. The greatest solution uptake was observed in the variant with colloidal silver at 0.02%. Leaf greenness index was the highest in the chrysanthemums placed in 0.04% silver solution.

***Keywords*:** cut flower, postharvest, SPAD, solution uptake

1. INTRODUCTION

Chrysanthemums (*Chrysanthemum* × *morifolium*) are some of the most important ornamental plants grown for cut flowers [1]. The most popular are spray varieties with natural

tendency to layering. Each year around 300 new chrysanthemum varieties are introduced on the Dutch market, and they all need to be verified in terms of cultivation requirements and application. Longevity of cut flowers depends on uptake and transport of water through shoot vascular system [1,3]. One of the reasons of vascular tissue occlusion are microorganisms, most often bacteria [12].

The bacteria develop on the surface of a cut at the lower part of a shoot and clog xylem lumen [3]. They also secrete toxic metabolites that block the vessels and enzymes that degrade plant cell walls [3,12]. The resulting microbiological block causes a drop in the entire plant turgor and leads to plant wilting [3].

Silver nitrate salts are very effective in limiting development of aqueous microflora but they are highly toxic to the environment. An alternative might be silver in the form of nanoparticles with their specific surface, large fraction of surface atoms and unique physical and chemical properties [4]. As demonstrated in many studies, nano-silver may be an effective agent prolonging postharvest longevity of cut flowers [2,4-13].

Carrillo-Lopez et al. [1] reported that the silver nanoparticles (10.2 nm) synthesized environmentally with *Chenopodium ambrosioides* at low concentration (0.01 mM and 0.05 mM) promoted inflorescences opening and increased vase life of chrysanthemum cv. 'Puma'. There is no available information on the use of colloidal silver for control of extending the vase life of cut flowers. Therefore, the present study was conducted to evaluate the effect of colloidal silver on postharvest longevity of the cut chrysanthemum flowers.

2. MATERIALS AND METHODS

Plant material included cut inflorescences of 'Feeling Green' chrysanthemum from Santini group. The flowers obtained from a greenhouse of a commercial grower in Szczecin (Poland). Inflorescences with six to eight flower heads were cut to a length of 50 cm, one third of leaves from the lower parts of the stems were removed, and the inflorescences were weighted using an electronic scale. Inflorescence longevity was prolonged with colloidal silver (purchased from Sigma-Aldrich) at three concentrations: 0.01%, 0.02 % and 0.04%. Controls were kept in water.

The inflorescences in groups of three were placed in 1000 ml flasks. The experiment was conducted in a room with controlled temperature and light conditions (20±2 ºC, 60±5 % RH, 12 h photoperiod, 10-12 μmol m^{-2} s^{-1} light intensity - white florescent tubes). Decorative value was expressed in days.

Chlorophyll Meter SPAD 502 (Konica-Minolta Corporation, Osaka, Japan) was used to evaluate leaf greenness index on the day when the decorative value was lost. The values indicated by the meter in the form of dimensionless SPAD units indicate leaf chlorophyll content. They are calculated based on the amount of radiation passed through a leaf at two wavelengths and differently absorbed by chlorophyll.

The measurements included three randomly selected, well-developed leaf blades in each inflorescence. On the day when the decorative value of the inflorescences was lost, their fresh weight and solution uptake were assessed. The experiment was performed in triplicates. Results were statistically analyzed using analysis of variance and Tukey's test for significance level 5%.

3. RESULTS AND DISCUSSION

Dissolving colloidal silver in water made the solution brown and the color intensity grew along with increasing silver concentration (Fig. 1).

Figure 1. Inflorescences of 'Feeling Green' chrysanthemum in the solutions of colloidal silver (from the left): 0 (control), 0.01%, 0.02%, and 0.04% on the fifth day of the experiment.

Table 1. Effect of colloidal silver concentration (%) on vase life, fresh weight loss, solution uptake and greenness index of 'Feeling Green' chrysanthemum

Colloidal silver concentrations (%)	Vase life (days)	Fresh weight loss (%)	Solution uptake (ml)	Greenness index (SPAD)
0 (Control)	18c*	32.9a	202b	22.1b
0.01	23ab	25.8b	181c	30.7ab
0.02	25a	28.7b	210a	25.7ab
0.04	21b	26.4b	170d	35.1a

* Date are presented as mean values (n = 9). Date with a different letter or combination of letters are statistically different ($P < 0.05$)

The study demonstrated significant effects of colloidal silver on longevity, weight loss, solution uptake and greenness index of chrysanthemum inflorescences (Table 1). The greatest longevity (25 days) was observed for the inflorescences kept in 0.02% silver solution. The shortest longevity (18 days) was noticed for the chrysanthemum inflorescences kept in water.

Similarly positive effect of nano-silver on longevity of cut flowers expressed in days was reported for carnations [2], roses [4], gerberas [5,6] and oriental lilies [9,10]. Inflorescence weight loss of the chrysanthemums kept in a solution of colloidal silver was significantly lower than in the control inflorescences, and the percentage of weight loss was independent of silver concentration. Positive effects of nano-silver on fresh weight of flowers were also reported in 'Avalanche' and 'Fiesta' [11], and 'Cherry Brandy' [4] roses. The greatest solution uptake (210 ml) was observed in the inflorescences kept in 0.02% colloidal silver. The lowest solution uptake (170 ml) was noticed in the inflorescences treated with 0.04% colloidal silver. Enhanced solution uptake in plants treated with nano-silver was also reported in gerberas [6], 'Bouquet' lily [10], and leafed shoots of *Acacia holosericea* [7].

Analysis of the effects of colloidal silver on leaf greenness index revealed significantly higher value (35.1 SPAD) of this parameter in the leaves of chrysanthemum inflorescences treated with the highest concentration of colloidal silver (0.04%). The index was similar in the other experimental variants (Table 1). Jowkar et al. [4] reported on increased chlorophyll content in the leaves of 'Cherry Brandy' rose following treatment of its shoots with nano-silver solution. In gerberas, increased greenness index of the stalks was observed following nano-silver application [6].

In conclusion, the use of colloidal silver increased postharvest longevity and reduced weight loss of cut chrysanthemum inflorescences. The study results suggest that colloidal silver may be used as an agent enhancing the quality of cut chrysanthemums but further research on determining its optimum concentration and application methods (e.g. conditioning) are necessary.

4. CONCLUSION

The results showed that the use of colloidal silver extended the vase-life of cut chrysanthemum flowers. The maximum vase-life was observed in flowers held in solution containing 0.02% colloidal silver.

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(Received 14 March 2017; accepted 28 March 2017)