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Effect of silver nanoparticles on the vase life and quality of cut chrysanthemum (*Chrysanthemum morifolium* L.) flower

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ABSTRACT

This experiment was carried out to evaluate the effect of silver nanoparticles (0, 5, 10 and 20 mgl^{-1}) on longevity and quality of cut chrysanthemum (Chrysanthemum morifolium L.*) flower. The flowers pretreated for 24 hours with pulse preservative solution and then were transferred to 8-hydroxyquinoline sulfate 300mg l^{-1}and sucrose 3%. Traits such as vase life, fresh weight loss and stem bacteria counting were measured. According to the results all treatments had positive effects on the vase life of flowers. Pulse solution with 10 mg l^{-1} silver nanoparticles increased the vase life compared to control 3.21 days. The results of the data analysis showed significant difference in all measured traits at levels 1 or 5%. The present study showed that post harvest life of cutchrysanthemum flower can be increased using appropriate concentrations of silver nanoparticles.*

Keywords: Vase life, Chrysanthemum**,** Silver nanoparticles, Fresh weight loss.

INTRODUCTION

Chrysanthemum with the scientific name of *Chrysanthemum morifolium* L. belongs to Asteraceae family and about 30 species of annual and perennial herbaceous, aroma woody and semi-woody exists around the world[17]. Chrysanthemum flowers is one of the most important flowers which is traded both as potted and the cut flower on world markets. So that, today it has the world's second class economy and the cultivation followed by roses[15].This flower has a long vase life that can be attributed to low ethylene production during senescence [5]. It is belonging to non-climacteric group and its senescence is in response to changes that occur in the carbohydrates content [1] and ethylene is not involved in this process [15]. The most important postharvest problem in Chrysanthemum, is yellowing leaves and inability to absorb water that is leading to premature leaf wilting[8].

Water interaction is the main factor determining the quality and survival of cut flowers [7] and water shortages usually cause obstruction in stem vessels [22]. Formation of air bubbles in the chrysanthemum stem vessels will be reduced the quality of flowers. This bubbles prevent from water transport in the stem and consequently the hydraulic resistance will increases and lead to severe water stress[23]. Vascular obstruction caused by air bubbles can remove using pulsing treatment of a detergent solution [8]. Prevent water absorption can be attributed to other factors such as closed vessels by microorganisms [23]. Hence, increasing anti-bacterial agents in the preservative solutions are effect[9].

8-hydroxyquinoline sulfate (HQS) is a bactericidal and an environment acidic agent which prevent from the closure of the vessels in the cross-cutting stem by chemical deposition [11]. Anju et al. [4] reported that cut Chrysanthemum flowers which are in preservative solution containing 8-hydroxyquinoline and sucrose have more life and maximum fresh weight than control.

Using the compounds of silver nanoparticles is relatively new for cut flowers [13, 21] and its importance as an antibacterial has been demonstrated[2, 14]. Liu et al. [13] investigated the effect of pulsing treatments (24 h) of silver nanoparticles (5, 10 and 20 mg l^{-1}) on vase life of gerbera flower and concluded that 5 mg l^{-1} pulsing treatment of silver nanoparticles due to the reduction in bacterial population and preventing the blockage of xylem will increase more than double vase life than control. Amani et al. [3] reported that using silver nanoparticles increased the amount of water absorbed, fresh weight and reduced lipid peroxidation than control in cut tuberose flower. Solgi et al. [21]in a study of gerbera cv. 'Dune'stated that the flowers that are maintained in 5 or 10 mg l^{-1}silver nanoparticles have longer vase life. There were no significant difference between the performances and 5 mg $l^{-1}$is the most suitable concentration. Qale Shakhani *et al*. [18] studied the effect of different levels of silver nanoparticles and humic acid on cut Alstroemeria flower and come to concluded that10 mg l^{-1} silver nanoparticles may be appropriate to increase the vase life.

The purpose of this study was to investigate the effect of silver nanoparticles on survival and quality of cutchrysanthemum flower and to introduce the best treatment to increase the vase life and improving its export in floriculture industry.

MATERIALS AND METHODS

In May 2012, cut Chrysanthemum flowers were harvested at the commercial stage, prepared from a producer in Tehran and immediately transported to the post-harvest laboratory of Islamic Azad University, Rasht, Iran for treat and evaluation the traits. First, Chrysanthemum stems cross-recutting (52 cm) in 38°C water and all leaves were removed from the bottom to the fourth node. This experiment was performed in a factorial complete randomized design with silver nanoparticles factor at 4 levels (0, 5, 10 and 20 mg l^{-1}) with 3 replicates and 12 plots. The 4 cut flowers were placed in each plot. Flowers pretreated during 24 hours with the pulse preservative solution and then were transferred into 300mgl^{-1}8-hydroxyquinoline sulfate and sucrose 3%. During the experiment, in order to avoid vascular occlusion, 1 cm recutting of stem end was done once every two days within water 38°C.

Conditions of the experiment site was including the 12 hour lighting and 12 hour dark that was provided by white fluorescent light. Light intensity was 12 µmol $m^{-2}s^{-1}$, room temperature, 20±2°C and relative humidity was 60-70%. Statistical analysis of data variance was performed with SAS software and mean comparison was based on LSD test. Traits were measured as follows.

Vase Life: Vase life defined as the distance between to start treatment to flower senescence which associated with petals wilt and the leaves changing color and was expressed as days.

Fresh Weight Loss: According to the initial fresh weight, final fresh weight and recuttings weight during vase life, fresh weight loss amount in gram for each cut flower was calculated according to the following equation:

Fresh weight loss = initial fresh weight-(final fresh weight +recuttings weight)

Stem Bacteria Counting: 24 hours after pulsing treatment, about 2 cm (0/5 g) was cut from the stem end and the bacteria colonies were counted by Van Meteren *et al*.[24] method.

RESULTS AND DISCUSSION

Vase Life

Analysis of data variance showed that the effect of different concentrations of silver nanoparticles on the vase life is statistically significant at 1% level (Table 1). Between different levels of silver nanoparticles, treatment with concentration of 10 mg $l^{-1}$and control showed the maximum (17.16 days) and the least vase life (13.95 days), respectively (Fig 1).

All concentrations of silver nanoparticles significantly increased the vase life than control that was consistent with the results of Liu et al.[13], Solgi et al.[21], Oraee et al.[16], Safa et al.[20] and Hoseinzadeh Liavali[10] studies about the effect of silver nanoparticles on the improving vase life of cut flowers. Increase the vase life of cut flowers using silver nanoparticles can be attributed to its anti-bacterial role [2]. Since the growth of microorganisms may increases in solutions containing sucrose [12], silver nanoparticles with its antimicrobial properties prevents vascular occlusion and prevents from the creation of water stress and early petals wilting due to reduced water absorption in the stem [6]. According to the results obtained from data average for vase life (Fig1), high concentration of silver nanoparticles (20 mgl^{-1}) was accounted the lowest increase in the vase life followed by control. This can be

attributed to the toxic effect of high concentrations of the treatment which this result is similar to that of Liu et al. [13].

Fresh Weight Loss

Analysis of data variance showed that the effect of silver nanoparticles on fresh weight loss trait is significant at the 5% level (Table 1). Silver nanoparticles with concentration of 10 mg l^{-1}(6.87 g) had the lowest fresh weight loss and 20 mg l^{-1}(10.59 g) silver nanoparticles and control (10.42 g) had the highest fresh weight loss (Fig 2). According to the results (Fig 1, 2), treatments which had the lowest fresh weight loss had the highest vase life and this corresponded with the Reid and Wu [19] who stated that flowers weight is regarded as an important index for flowers wilt. It can be stated that silver nanoparticles with antimicrobial characteristic and prevent from vascular occlusion [13], reduced water stress and in turn less fresh weight has been reduced.

Stem Bacteria Counting

The effect of different concentrations of silver nanoparticles on the bacteria growth rate of stem end is significant at 1% (Table 1). Silver nanoparticles with concentration of 20 mg l^{-1}had the lowest stem bacteria colonies (23.33) compared to control and there was no significant difference between the three levels (Fig 3). The data showed that all treatments were effective in reducing bacteria growth compared to control. The positive effects of silver nanoparticles can be attributed to prevent from bacterial growth in the vase solution and stem end[14]. So it seems that silver nanoparticles due to the decrease in the population of bacterial and prevent the blockage of xylem increases the vase life of cut chrysanthemum flower that this corresponded with the results of Liu et al.[13], Solgi et al.[21] about the effect of silver nanoparticles on the reduction of bacteria colonies of cut flowers.

Table 1. Analysis of variance of the effect of silver nanoparticles on some traits of *Chrysanthemum morifolium*

Source of variations	df	Vase life	Fresh weight loss	Stem bacteria counting
Silver nanoparticles	3	26/514**	49/658*	16343/243**
Error	32	3/229	15/402	1224/562
Total	35	-	-	-
CV(%)	-	11/751	44/829	63/123

***: significant at 1%, *: significant at 5%, ns: no significant*

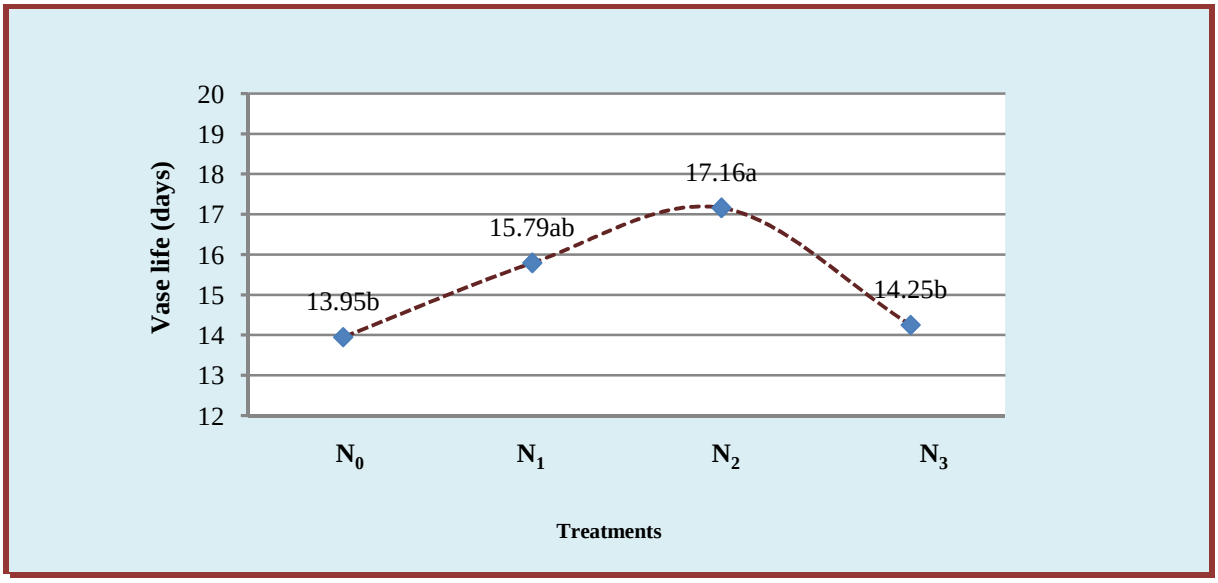

Fig 1. Effect of silver nanoparticles on vase life of *Chrysanthemum morifolium* L.

N_0: control,N_1: 5 mg l^{-1} SN,N_2: 10 mgl^{-1} SN, N_3:20 mg l^{-1} SN

**According to LSD test, means with the same letters are not significantly different..*

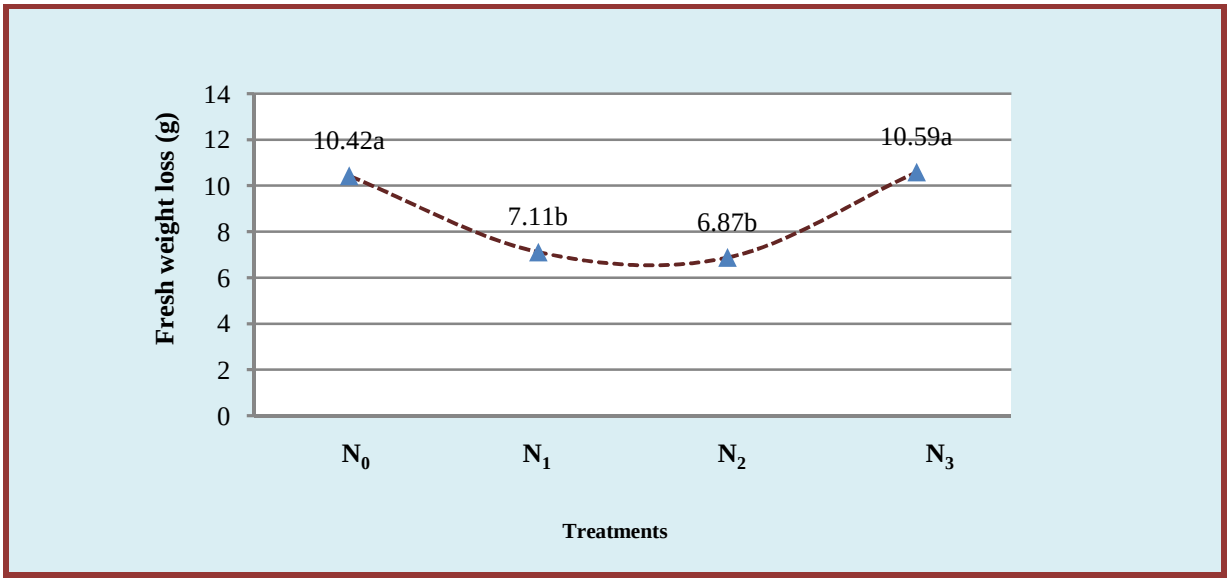

Fig 2.Effect of silver nanoparticleson Fresh weight lossof *Chrysanthemum morifolium* L.
N_0: control,N_1: 5 mg l^{-1} SN,N_2: 10 mgl^{-1} SN, N_3:20 mg l^{-1} SN
**According to LSD test, means with the same letters are not significantly different.*

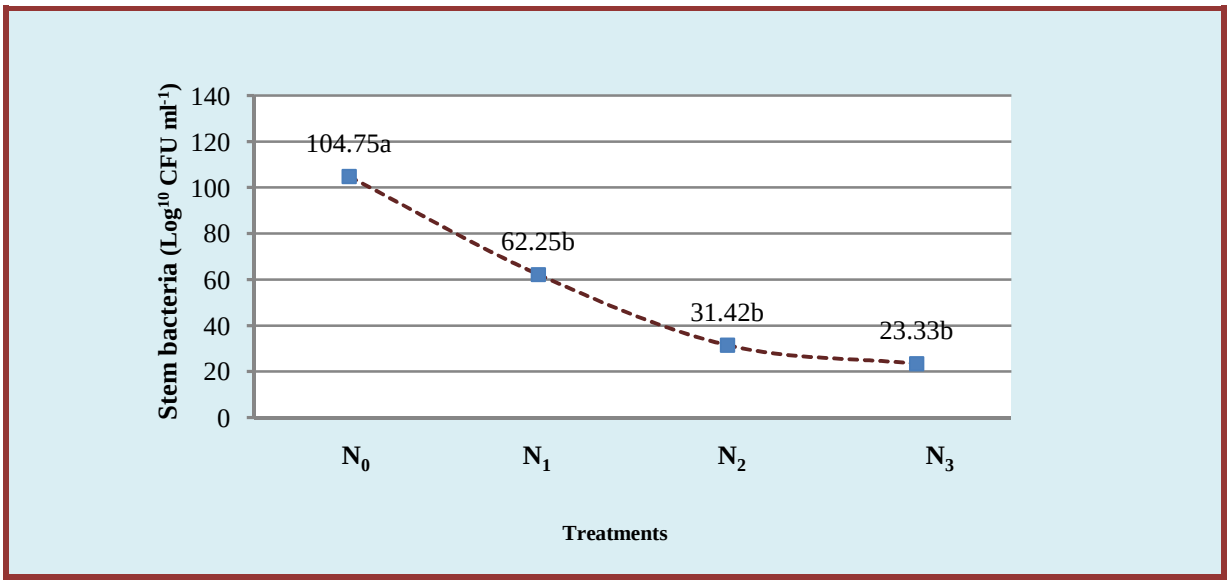

Fig 3.Effect of silver nanoparticles on Stem bacteria of*Chrysanthemum morifolium* L.
N_0: control,N_1: 5 mg l^{-1} SN,N_2: 10 mgl^{-1} SN, N_3:20 mg l^{-1} SN
**According to LSD test, means with the same letters are not significantly different.*

CONCLUSION

The results showed that silver nanoparticles with antimicrobial properties and prevent vascular occlusion decreases water stress and increased vase life, reduce stem bacteria and reduce less fresh weight of cutchrysanthemum flower. Therefore, it is recommended that silver nanoparticles as appropriate compound, low cost and without adverse effects on the environment be used to increase the survival and succulence of cut flowers.

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