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Improvement of Vase Life and Postharvest Factors of *Lilium orientalis* 'Bouquet' by Silver Nano Particles

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Abstract

Lily is one of the prominent cut flowers on the international markets, so that its longevity is an important post-storage attribute. Blockage of xylem vessels and insufficient water uptake contributes to the short vase life of cut flowers. Bacteria block stem xylem vessesls and because of that reduce rates of water supply to flowers. Nano silver has antimicrobial effects at low concentration. Prolongation of vase life cut lilies (*L. orientalis* 'Bouquet') flowers by nano-silver particles was studied. Cut flowers were kept in vase containing 5, 15, 25, 30 ppm of nano-silver solutions and deionized water as control treatment under controlled conditions. During vase period, vase life, vase solution uptake, initial fresh and bacterial numbers were measured. According to the results, all nano-silver treatments extended the longevity of cut flowers compare to control. Among these treatments the concentration of 30 ppm of silver-nano showed the highest vase solution uptake, initial fresh weight and lowest bacteria colony during the first 2 days of vase life. It was concluded that nano silver particles had a high potential for eliminating of bacterial contaminants. These for suggest that application of solutions containing superior advantageous of nano-silver particles is recommended to improve postharvest of *L. orientalis* 'Bouquet'.

Keywords: antimicrobial, bacteria, cut flower, vascular occulsion, nano-silver particles, vase life

Introduction

Hybrid lilies are a diverse group of plant with numerous forms and colors, causing a good rank in world flower market (Vonk Noordegraff, 1998). Short vase life of flowers could be one of the most important reasons for the inability of florists to develop any suitable market. The length of vase life is one of the most important factors for quality of cut flowers.

The main cause of abbreviated vase life in cut flowers is failure in water relations. Blockage of water conducting xylem vessels contributes to the short postharvest life of many cut flowers Jedrzejuk and Zakrzewski (2009). Stem blockage might be microbial or physiological (Louband and van Doorn, 2004).

Several natural and chemical substances have been applied to inhabit bacterial growth and so prolong the vase life of cut flowers (Damunupola *et al.*, 2010; Xie *et al.*, 2008). Many germicides such as HQS, silver nitrate, aluminium sulphate, copper sulphate, cobalt chloride and etc, have been used in cut flowers (Van Meeteren *et al.*, 2000). However, usage of these chemical substances for different cultivars needs to be examined. Rai *et al.* (2009) repoted that silver nano-particles (SNPs) shows efficient antimicrobial property compared to other salts due to their extremely large surface area, which provides better contact with microorganisms. Howerver, there are few reports on effect of SNPs alone on cut flowers. Liu *et al.* (2009) and Solgi *et al.* (2009) investigated how SNPs could improve the vase life of gerbera cultivars. Lu *et al.* (2010) also assessed the effect of SNPs on vase life extension of cut rose. The purpose of this study was to evaluate the potential of SNPs to extend postharvest life and suggest a suitable concentration for *L. orientalis* 'Bouquet'.

Materials and methods

Plant material

L. orientalis 'Bouquet' was grown in research greenhouse of Ferdowsi University of Mashhad, Iran. Stems with two flower buds were harvested at commercial maturity stage. Harvested stems were transported quickly to laboratory. At the laboratory, the flowers selected for uniformity, lowermost leaves from all stems were trimmed off to 35 cm and stem end of flowers were cut off under distill water to avoid air embolism. Thereafter cut flowers were maintained in a controlled environment at 23±2 °C, 60±5% relative humidity and 20 μmol $m^{-2} s^{-1}$ irradiance cool white florescent lamps under a daily light period of 12 h. Vases were arranged in randomized complete block design. Each treatment involved 4 replications and 8 cut cut flowers. Statistical significance between mean values

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was assessed according to LSD test at 0.05 probability level using JMP (7) statistical software.

Nano-silver particle preparation

The silver nano-particles which used in this research were 20 nm average in size (Fig. 1). Various concentrations of silver-nano particles (5, 15, 25 and 30 ppm) were used. Dieionized water was used as control. Vase solution prepared freshly. To prevent contamination and to minimize evaporation, vases were covered with a sheet of thin polyethylene films.

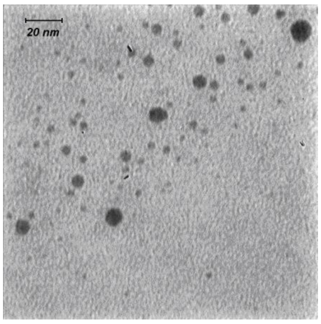

Fig. 1. Transmission electron microscopy (TEM) micrograph of silver nano-particles (20 nm)

Determination of vase life

Vase life was calculated from the time of harvest to the time when 50% petal color fading.

Relative fresh weight

The relative fresh weight (RFW) of cut stem was recorded (Pompodakis *et al.*, 2004). Experiments were evaluated at every 24 hours, each flower was weighed in order to estimate the average daily change in fresh weight (gg-1 intial fresh weight day-1) (He *et al.*, 2006).

Vase solution uptake

The weights of vases without their cut flowering were recorded daily during the vase life evaluation period using a balance. Average daily Vase solution uptake rate was calculated by the formula: vase solution uptake rate (g stem -1 day-1) = (St-1_St); where, St is weight of vase solution (g) at t =day 1, 2, etc., and St-1 is weight of vase solution (g) on the previous day.

Bacterial count

The basal 2 cm from the stem ends was excised daily under distill water. Then, the explants were washed three times with sterile deionized water. They were ground and diluted with 0.9% sterile normal saline. Then liquid extract (80 μl) were spread on nutrient agar plate. Before enumeration of bacteria, they were incubated at 37 °C for 24 h (Balestra *et al.*, 2005). Finally bacterial colonies were calculated with digital colony counter.

Results and Discussion

Vase life

All Nano silver treatments significantly (*p ≤ 0.05) enhanced vase life of cut flowers (Tab. 1). 30 ppm SNPs treatment had the longest vase life among the other treatments.

Tab. 1. Vase life of *L. orientalis* 'Bouquet' various SNPs treatments

Treatments	Vase life (days)
Deionized water	6.5 ± 0.3 c
5	9.1 ± 0.3 b
15	8.9 ± 0.2 b
25	10.9 ± 0.3 a
30	11.3 ± 0.3 a

Vase life data are means ± standard error

Relative fresh weight and water uptake

Typically, cut flowers initially increase and subsequently decrease in relative fresh weight (RFW) and vase solution uptake (VSU) (Rogers, 1973). RFW and VSU of all NS treatment were higher than control treatment (Fig. 2 and 3). VSU of cut lilies in deionized water had decreased rapidly after day 2, while amount of vase solution uptake in SNPs treatments decreased slightly. Keeping the cut flowers with SNPs solution caused highest solution uptake and maintained fresh weight of the cut flowers at high values. The results showed that the SNPs significantly differences (*p ≤0.05) comparing with control. 30 ppm concentration had the highest relative fresh weight, but no significant differences were seen with 25 ppm.

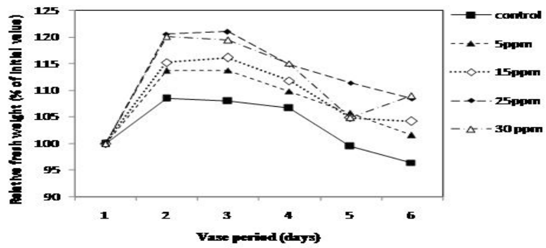

Fig. 2. Effect of different concentration of SNPs on relative fresh weight during first six days of *L. orientalis* 'Bouquet' vase life

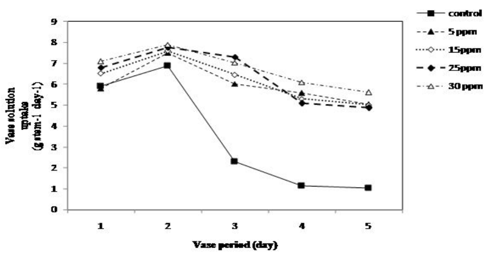

Fig 3. Effect of different concentration of SNP on vase solution uptake during first five days of *Lilium* flowers

Number of bacteria in the vase solution

Significant difference (*p ≤ 0.05) in number of bacteria in vase solution was observed between control and SNPs treatments. Number of bacteria in the vase solution tended to increase throughout the vase period for all treatments (Fig. 4). Maximum average of bacterial count was recorded control treatment. The bacterial populations were relatively low at first, but increased rapidly after 1 to 2 days.

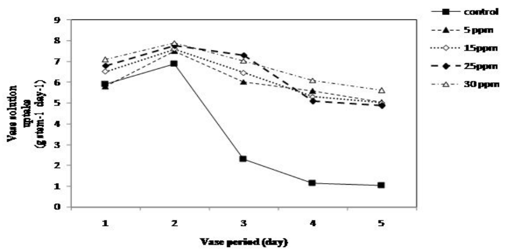

Fig. 4. Number of bacteria in vase solution of cut Lilium during first five days of vase life

Inclusion of a high number of bacteria in the vase solution was found to reduce the longevity of cut flowers. Bacteria apparently led to physical xylem occlusion, which resulted in a decrease of water uptake and a low water potential (Van-Doorn and Reid, 1995). Bacteria also induced physiological plugging indirectly by the releasing toxic metabolites and/or enzymes into the holding water (Van-Doorn and Perik, 1990). Some bacteria were also reported to produce ethylene that causes senescence of the cut flowers (Fujino *et al.*, 1980).

Undoubtedly, the water relations of cut lilies involves a dynamic interaction among stem dehydration, inspired air, stomatal aperture, environmental conditions and growth of bacteria in the vase solution. Van Doorn *et al.* (1989) reported that there was a positive correlation between number of bacteria and water conductivity of stems. Our results are in agreement with the finding of Solgi *et al.* (2009) and Lu *et al.* (2010).

The SNPs show efficient antimicrobial property compared to other salts due to their extremely large surface area, which provided better contact with micro organism (Rai *et al.*, 2009). SNPs in most researches are considered to be non-toxic, but due to their small size and variable characteristics they are suggested to be dangerous to the environment. In this experiment, toxic effects of SNPs on stems cuts did not observed, while Liu *et al.* (2009) reported toxic effects of SNPs with high concentrations. The exact mechanism of action of silver on the microorganisms is unknown (Rai *et al.*, 2009). They also reported when SNPs got into the bacterial cell, it forms a low molecular weight region in the center of the bacteria to which the bacteria conglomerates, thus, protecting the DNA from the silver ions. The SNPs attack the respiratory chain, cell division and finally leading to cell death (Morones *et al.*, 2005).

The SNPs with their unique chemical and physical properties are proving as an alternative for the development of new antibacterial agents. They have potential for wound dressing, coating for medical devices, coating textile fabrics and etc. (Rai *et al.*, 2009).

The beneficial effect of SNPs treatments in this investigation is in agreement with the results obtained by other researchers (Nomiya *et al.*, 2004; Sondi and Salopek-Sondi, 2004).

Owing to strong antibacterial properties, silver nano particles are drastic tools for extending cut flowers postharvest life. However, further studies must be conducted to confirm antimicrobial influences, bacteria develop resistance and cytotoxicity test of silver nano particles towards human cells.

Conclusions

Nanotechnology involves the tailoring of materials at atomic level to attain unique properties, which can be suitably manipulated for the desired applications. Xylem Blockage has been mentioned to be mainly due to microbial proliferation. Owing to strong antibacterial properties, silver nano particles are drastic tools for extending cut flowers postharvest life.

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