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EFFECT OF NANO SILVER AND SILVER NITRATE ON VASE LIFE AND KEEPING QUALITY OF CUT ROSE FLOWERS AFTER PERIODS OF COLD STORAGE

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ABSTRACT

This study was conducted at the Postharvest Laboratory of Vegetable and Ornamental Plants Department, Faculty of Agriculture, Mansoura University, Egypt, during 2014 and 2015years. It aimed to study the effect of silver nitrate, nano-silver particles and cold storage on vase life and quality of cut roses. Cut roses (*Rosa hybrida L*.) of two local cultivars (Red and White) were placed in distilled water, 10 ppm silver nitrate, or 5 ppm nano silver particles for three hours either fresh (without storage) or pulsed after they have been wrapped in newspapers and stored dry (without water) inside a refrigerator at 5 ±1 °C for 24, 48, and 72 hours. Vase life and quality (expressed as maximum increase % of original fresh weight) of the flowers were determined under laboratory conditions (24 hours fluorescent light about (1500 lux), 25 ± 2˚C, and 50 ± 5% relative humidity (RH)). The results showed that the two cultivars have different vase lives as the white cultivar had longer vase life than the red one, while the red gained more fresh weight than the white one.As for the effects of storage period, data showed that increasing the storage period reduced the useful vase life of the flowers, while resulted in more weight gain by the flowers.Both silver nitrate and nano silver pulse extended the vase life of the flowers with favor to silver nitrate pulse. The best treatments led to the longest vase life was that of the non-stored flowers pulsed with silver nitrate for both white (9.8 days), and the red cultivar (7 days).

INTRODUCTION

Roses are woody perennials of the genus Rosa that belongs to the family Rosaceae and comprises of over 100 species and thousands of cultivars. Roses are the most famous widely grown and highly demanded cut flower in the world and produced for both local market and for export as well. Generally they are harvested and cut when in bud, and held in refrigerated conditions until ready for display at their point of sale.Globalization of cut flowers market requires quality management of cut flowers in order to achieve quality of cut flowers and their vase life at the final consumer (Meeteren*et al.,* 2013).Finger and Barbosa (2006) reported that many techniques are available to extend cut flowers preservation, including the use of flower preservatives and controlling of temperature.

The cut rose flowers of produced during summer in Egypt have short vase life and suffers great losses due to exposure tofield heat and high temperature during transportation or storage. Some florists therefore, sell their cut flowers quickly without thought or care of customer satisfaction.

Mosqueda-Lazcares*et al.,* (2012)recommended dry handling of cut rosestems, because it reduces the costs and maintained the quality of the flower at the end consumer.Cut flowers have intensive respiration, which deplete the limited reserves of carbohydrates stored in the cut stems.The reduction of temperature reduces respiration, and ethylene production, as well as its action.

Rogers (1973) reported that the scientific basis of refrigeration in prolonging the keeping quality of all fresh living horticultural products is to slow down respiration and biochemical reaction leading to aging of plant tissues.Cold storage at the right temperature to a specific cut flower is necessary factor to improving quality and prolongation of its vase life. (Namesny, 2006).Estimating vase life after long storage could be improved by estimating the maximum rate of vase life-loss for a specific cultivar using the vase life of fresh cut flowers without storage as a control (Meeteren*et al.,* 2013). .

Vase life termination for many cut flowers is characterized by wilting even when they are constantly held in water (He *et al.,* 2006). Water balance is a major factor determining quality and longevity of flowers. It is influenced by water uptake and water loss and the balance between these two processes. (DaSilva, 2003).Blockage of xylem vessels and insufficient water uptake contributes to the short vase life of cut flowers. Bacterial blockage of stem xylem vessesls causes a reduction in rates of water uptake to flowers leading to water stress and wilting (van Doorn, 1999).

Silver ion (Ag+) is an effective inhibitor of growth of bacterial and other microorganisms. (Feng*et al.,* 2000 and Rai*et al.,* 2009).Inclusion of Silver nitrate (10 to 50 ppm) is used in many cut flower preservative solutions to effectively reduce the number of bacteria in the vase water and extend flower longevity. However, silver nitrate is easily photo-oxidized and, reacts with chlorine in the tap water to form silver chloride which precipitates and induce blackening of the solution and the flower stems (Halevy and Mayak, 1981).

Silver nanoparticles (NPs)are clusters of silver atoms 1 to 100 nm in diameter and is the most commonly used nano formulation as an antimicrobial agent (Chaloupkaet al., 2010;Morones et al., 2005).

Because of their high surface area to volume ratio, along with other chemical and physical properties, Nano silver formulations are highly effective against microorganisms (Rai*et al.,* 2009) In addition, they possessa great efficacy against a large number of bacteria species (Morones*et al.,* 2005) and low toxicity to human health.

The use of nano-silver compounds (NS) as a pulse treatment for cut flowers is relatively a new application (Liu *et al.,* 2009; Solgi*et al.,* 2009; AbdelKader, 2012,Jowkar andHassanzadeh, 2013).

The aim of the research is to study the effect of cold storage and chemical preventives like silver nitrate and nano–silver on the vase life and quality of two cut rose (*Rosa Hybrida L.)*local cultivars.

MATERIALS AND METHODS

This study was conducted at the Postharvest Laboratory of Vegetable and Ornamental Plants Department, Faculty of Agriculture, Mansoura University, Egypt, during 2014 and 2015years. It aimed to study the effects of nanosilver and silver nitrate on vase life and keeping quality of cut rose flowers after periods of cold storage.

Plant material:

Cut roses (*Rosa hybrida L.*) two local cultivars (White and Red)were obtained from Gomaa Flower Farm Rose near El-Mansoura duringspring (march and April) of 2014 and 2015.

Harvesting:

The flowers were harvested early in the morningwhenhe flower buds sepals just start to reflex, and the corolla was tightly folded. After harvest, flowers were transferred to the postharvestlaboratory where they were graded according to the size of the flower heads and the length of sterns. Flowers of each cultivar were divided into 4 main groups; freshly treated flowers, and flowers stored for 24, 48, and 72 hrs in the refrigerator.

Each group of flowers of each cultivar subjected to storage was wrapped in newspapers and placed inside a refrigerator at 8 °C for 24, 48, and 72 hours.

For freshly treated flowers, flowersof each cultivar were divided into three sub groups; each sub group consisted of 6 flowers, and were placed in three different solutions; Distilled water (DI), Nano-silver particles (NSP) at 5 ppm, and Silver nitrate (SN) at a concentration of 10 ppm. Three hours later, flowers were taken out of their solutions and their leaves were removed from the lower part of the stem leaving only the leaves on the threeuppermost nodesof the stem, and the stems were cut to a length of 45 cm for red cultivar and 40 cm for white cultivar. Flowers were weighed, and their original fresh weight was recorded, and each flower was placed individually in a graduated cylinder (100 ml) containing the DI watertill the end of their vase lives under Laboratory conditionsof 24 hours fluorescent light about (1500 lux), 25 ± 2˚C, and 50 ± 5% relative humidity (RH). A group of 6 graduated cylinders were filled with water only without flowers were set in order to calculate the average daily water evaporation from the cylinders, as the average decrease in water level in the five cylinders. Solution uptake by the spike was calculated as the daily decrease in solution of the graduated cylinder containing the spike, after subtracting the daily evaporation value.

After each storage period, flowers were taken out of the refrigerator, and treated exactly as the fresh flowers did.

The treatments of this experiment were: two cultivars, four storage periods (including non-stored flowers), and three solutions (including DI water).

Data collected and measurements:

Vase life: was measured as number of days from the time they were placed in the graduated cylinders until the end of their useful vase life. The flowers were recognized dead when they either lost 10% of their maximum fresh weight, showed severe wilting symptoms, showed bent neck, or their color was changed to a disagreeable color(AbdelKader, 2012; He *et al.,* 2006).

Maximum increase of fresh weight %:

The percentage of maximum increase in fresh weight was calculated in all experiment by subtracting the original fresh weight from the maximum weight of the spike and multiplying it by 100.

Experimental Design:

Each treatment contained six flowers and each flower was considered as replicates and each experiment was carried out at two times in each season during each year. Treatments were arranged and analyzed as a Split-split plot design with 6 replicates.

Statistical analysis:

The obtained data were statistically analyzed according to Gomez and Gomez (1984). Costat statistical analysis program was used, and the differences between the means of the treatments were considered significant when they were equal or more than least significant difference (L.S.D) at 5% level. A combined analysis was carried out for the data of several experiments.

RESULTS

I. EFFECTS ON VASE LIFE

Table (1) shows the effects of main treatments on the vase life of cut rose flowers. It is clear from the data that the two cultivars have different vase lives as the white cultivar had longer vase life than the red one. As for the effects of storage period on vase life of cut roses, Data showed that the longest significant vase life was achieved using fresh flowers without storage (7.3 days), followed by those stored for 24 and 48 hours, while flowers stored for 72 hours had the shortest vase life. Storage of the cut flowers shortens the time of the flower exhibition in the vase. Concerning the effect of pulsing treatments, it is also clear from the same table that silver nitrate pulse was more effective in extending the vase life more than nano silver particles. However, both chemicals did not significantly differ, but the flowers that were placed in water only had the shortest significant vase life.

Table (1) Effects of the main treatments on the mean vase life of cut rose flowers.

Vase life (days)					
Treatments A (Cultivar)	**Means A**	**Treatments B (Storage period)**	**Means B**	**Treatments C (Pulse treatments)**	**Means C**
RED	5.8	Fresh	7.3	Distilled water (DW)	5.8
		24 Hours	6.0	Silver nitrate (SN)	6.6
White	6.6	48 Hours	5.9	Nano silver (NSP)	6.3
		72 Hours	5.5		
LSD 5%	0.5		0.6		0.4

Data in Table (2) showed the effects of different interactions between treatments on the vase life of cut rose flowers. As for the interaction between cultivar and storage period (A*B), the white cultivar treated with different storage periods had longer vase life than their comparable red ones. The longest vase life was that of fresh non stored white cultivar (averaged 8.1 days) followed by that of fresh non stored red cultivar (averaged 6.4 days), while the shortest vase life was that of the red cultivar stored for 72 hours ((averaged 5.2 days). Concerning the effects of the interaction between cultivar and pulsing treatments (AC), it is clear that the white cultivar flowers pulsed with silver nitrate had longest vase life, followed by those pulsed with nano silver, while the shortest were flowers of both cultivars pulse with distilled water (control). As for the interaction between storage period and pulsing treatments (BC), data showed that fresh non stored flowers pulsed with silver nitrate had the longest vase life, followed by those pulsed with nanosilver and those stored for 24 hours and pulsed with silver nitrate, while flowers pulsed with distilled water and stored for 72 hours had the shortest vase life. As for the interaction among all treatments (ABC), it is obvious that the longest vase life was that of the non-stored white cultivar flowers pulsed with silver nitrate (9.8 days), while the best treatment for the red cultivar was the fresh non stored flowers pulsed with silver nitrate (7 days).

Table (2). Effects of the interactions among different treatments on the mean vase life of cut rose flowers.

Treatments / **Cultivar (A)**	**Pulse solutions (C)** / **Storage period (B)**	**Vase life (days)** Distilled water (DW)	Silver nitrate (SN)	Nano silver (NSP)	Means A*B
RED	Fresh	6.0	7.0	6.3	6.4
	24 Hours	6.0	5.3	6.5	5.9
	48 Hours	6.0	5.8	5.3	5.7
	72 hrs	5.0	5.0	5.5	5.2
WHITE	Fresh	6.5	9.8	8.0	8.1
	24 Hours	5.3	7.5	5.8	6.2
	48 Hours	5.8	6.3	6.5	6.2
	72 Hours	5.8	6.0	6.0	5.9
					LSD AB = 0.8
	LSD 5% ABC = 1.2				

Pulse solutions (C) / **Storage period (B)**	**Vase life (days) Means BC** Distilled water (DW)	Silver nitrate (SN)	Nano silver (NSP)
Fresh	6.3	8.4	7.1
24 Hours	5.6	6.4	6.1
48 Hours	5.9	6.0	5.9
72 Hours	5.4	5.5	5.8
LSD BC=0.9			

Pulse solutions (C) / Cultivar (A)	Vase life (days) Means AC: Distilled water (DW)	Silver nitrate (SN)	Nano silver (NSP)
RED	5.8	5.8	5.9
WHITE	5.8	6.6	6.2
LSD AC= 0.6			

II. EFFECTS ON QUALITY

Table (3) shows the effects of main treatments on flower quality expressed as the maximum fresh weight of cut rose flowers. It is clear from the data that the two cultivars have different increases in their weights as the red gained more fresh weight than the white one. As for the effects of storage period on maximum fresh weight of cut roses, data showed that increasing the storage period resulted in more weight gain by the flowers. Concerning the effect of pulsing treatments, it is also clear from the same table that flowers pulsed with nano silver resulted in slight increase in fresh weight, followed by those pulsed with silver nitrate. However, both chemicals did not significantly. Both silver nitrate and nano silver eliminate bacterial growth in the vase solution resulting in more water uptake and, consequently, more fresh weight.

Table (3) Effects of the main treatments on the mean maximum fresh weight % of cut rose flowers.

Maximum fresh weight (% of original weight)					
Treatments A (Cultivar)	**Means A**	**Treatments B (Storage period)**	**Means B**	**Treatments C (Pulse treatments)**	**Means C**
RED	113.5	Fresh	111.3	Distilled water (DW)	112.3
		24 Hours	113.6	Silver nitrate (SN)	113.2
White	113.0	48 Hours	113.2	Nano silver (NSP)	114.3
		72 Hours	115.0		
LSD 5%	0.5		3.6		NS

Data in Table (4) showed the effects of different interactions between treatments on the maximum fresh weight of cut rose flowers. As for the interaction between cultivar and storage period (A*B), the white cultivar stored for 72 hours gained more fresh weight (averaged 116.9 %) than other treatments, while the fresh non stored white cultivar recorded the least increase in fresh weight (averaged 110.1%). Concerning the effects of the interaction between cultivar and pulsing treatments (A*C), it is clear that the red flowers pulsed with nano silver gained more weight (averaged 115.4%), followed the white cultivar pulsed with silver nitrate (114.3%), while the least weight gain was that of the white flowers pulsed with distilled water only (averaged 111.5%). As for the interaction between storage period and pulsing treatments (B*C), data showed that flowers pulsed with nano silver and stored for 24 hours recorded the heaviest maximum fresh weight (averaged 118.5%), followed by those stored for 72 hours (averaged 116.4 %) and flowers pulsed with silver nitrate and stored for 72 hours (averaged 115.3 %) respectively. Regarding the interaction among all treatments (A*B*C), it is obvious that the highest maximum fresh weight % was that of the red cultivar flowers pulsed with nano silver and stored for 24 hours (124.3 %), while the lowest was that of the fresh non stored white cultivar flowers (108.5 %).

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DISCUSSION

The results showed that the two cultivars have different vase lives as the white cultivar had longer vase life than the red one, while the red gained more fresh weight than the white one.These differences are mainly related to the inherent morphological characteristics of each cultivar such as size of leaves and flower head as well as to other botanical ones. Differences in vase life among different rose cultivars reported previously by many authors (Iftikhar*et al.,* 2012;Mosqueda-Lazcares*et al.,* 2012).

As for the effects of storage period, data showed that increasing the storage period reduced the useful vase life of the flowers, while resulted in more weight gain by the flowers. Similarly, Iftikhar*et al.* (2012) reported that increasing the length of storage period reduced vase life. Flowers stored dry for a longer period would lose water during storage; as these flowers are placed in water the absorb more water because of the differences in water potential between the flower and the vase solution resulting in an increase in their weights.Jain*et al.* (2009) reported that wrapping the cut flowers of rose(cv. First Red) in cellophane paper and storing them for 3 days at 2 degrees Creduced their water loss compared with wrapping them in newspaper or kraft paper. However, early report by Faragher*et al.*(1984) concluded that the water loss during cold storage is not the cause of the reduced vase life of cold stored rose flowers.

Data also showed that both silver nitrate and nano silver pulse extended the vase life of the flowers with favor to silver nitrate pulse.Van Doorn (1999) indicated that the vase life of many flowers is limited by an occlusion that take place in the stem, which retards water uptake and leads to water stress. Both silver nitrate and nano silver eliminate bacterial growth in the vase solution resulting in more water uptake and, consequently, better water balance within the cut flower tissues leading to longer vase life. This view is supported by several researchers (Liu*et al.,* 2009; Alimoradi, 2013; Asgari*et al.,* 2013; Hashemabadi*et al.,* 2013; Hatamzadeh and Shafyii-Masouleh, 2013) who showed that silver nitrate and nano silver inhibited bacterial growth in the vase solution and/or in cut stem vessels resulting in more water uptake and longer vase life. In addition, showed that silver nitrate and nano-silver retarded relative fresh weight reduction.

The best treatments led to the longest vase life was that of the non-stored flowers pulsed with silver nitrate for both white (9.8 days), and the red cultivar (7 days). Therefore, many researchers includingAbadi*et al.* (2013) indicated that differences in response of different flowers require evaluation of storage method and duration for each species and cultivar.

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تأثير مركب النانو فضة ونترات الفضة على عمر وجودة زهور الورد المقطوفة بعد فترات من التخزين البارد

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تم عمل هذة الدراسة في معمل لاعداد والتخزين الزهور بقسم الخضر والزينة بكلية الزراعة جامعة المنصورة في مصر خلال العامين ٢٠١٤-٢٠١٥ هدف البحث الى دراسة تأثير نترات الفضة والنانو فضة والتخزين البارد على عمر وجودة زهور الورد تم وضع صنفان محليان من زهور الورد (احمروابيض) اما في ماء مقطر اوفي ١٠ جزء/مليون من نترات الفضة او(٥) جزء /مليون من النانو فضة لمدة ٣ ساعات كمعاملة انباض وذلك اما للزهور الطازجة (بدون تخزين)او بعد ان تم لفهما باوراق الجرائد وتخزينها بدون ماء في الثلاجة على درجة ٥±١°م لمدة ٢٤ ساعة او ٤٨ ساعة او ٧٢ ساعة تم تقدير عمر الزهور وجودتها (لنسبة المئوية لاقصى زيادة في الوزن الطازج الاصلي للزهرة) تحت ظروف المعمل (٢٤ساعة اضاءة من لمبات فلورسنت حوالي الى ١٥٠٠ لوكس ودرجة حرارة ٢٥±٢ °م و ٥٠ ±٥ % رطوبة نسبية)

اظهرت النتائج اختلاف الصنفان في عمر الزهرة حيث كان عمر الزهور الصنف الابيض اطول من الاحمر الا انه كانت نسبة الزيادة القصوى لوزن الزهرة للصنف الاحمر كانت اكبر من تللك للصنف الابيض ، وبالنسبة لتاثير طول فترة التخزين فقد اظهرت النتائج ان زيادة فترة التخزين ادت الى نقص عمر الزهرة الاانها ادت الى زيادة نسبة الزيادة القصوى في الوزن كما ان معاملة الانباض بكل من نترات الفضة والنانو فضة اديا الى زيادة عمر الزهرة مع افضلية نسبة النترات ، ولقد كانت اقضل المعاملات التي ادت لاطول عمر للزهور هي معاملة الانباض بنترات الفضة للزهور الطازجة غير المخزنة لكل من الصنفين الابيض(٩,٨يوما) والاحمر (٧يوم).

Table (4). Effects of the interactions among different treatments on the mean maximum fresh weight % of cut rose flowers.

Treatments / **Cultivar (A)**	**Pulse solutions (C)** / **Storage period (B)**	**Maximum fresh weight %** – **Distilled water (DW)**	**Silver nitrate (SN)**	**Nano silver (NSP)**	**Means A*B**
RED	Fresh	113.5	113.3	110.8	112.5
	24 Hours	112.0	110.04	124.3	115.4
	48 Hours	115.6	109.96	113.7	113.0
	72 hrs	111.1	115.07	112.9	113.0
WHITE	Fresh	109.2	112.7	108.5	110.1
	24 Hours	109.3	113.1	112.6	111.7
	48 Hours	112.2	116.1	111.7	113.3
	72 Hours	115.5	115.5	119.9	116.9
LSD 5%ABC = 8.4					LSD AB=4.9

Pulse solutions (C) / **Storage period (B)**	**Maximum fresh weight % Means BC** – **Distilled water (DW)**	**Silver nitrate (SN)**	**Nano silver (NSP)**
Fresh	111.4	113.0	109.7
24 Hours	110.7	111.6	118.5
48 Hours	113.9	113.0	112.7
72 Hours	113.3	115.3	116.4
LSD BC=6.0			

Maximum fresh weight % Means AC

Pulse solutions (C) Cultivar (A)	Distilled water (DW)	Silver nitrate (SN)	Nano silver (NSP)
RED	113.1	112.1	115.4
WHITE	111.5	114.3	113.2
LSD AC=NS			