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PULSING WITH SUCROSE AND SILVER NITRATE ENHANCE WATER UPTAKE AND RESULT IN ALONG VASE LIFE IN TAIF ROSE CUT FLOWERS (*Rosa damascena*. CV. TRIGINTIPETALA)

ELGIMABI M.N.E.E.*

Department of Biology, Taif University, Saudi Arabia.
*Corresponding Author: Email- nourde1@yahoo.com

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Abstract- An experiment was carried out on Taif rose cut flowers cv. (Trigintipetala) to study the effect of pulsing with sucrose and silver nitrate ($AgNO_3$) on vase life and other parameters. In the trial, sucrose and $AgNO_3$ at 4 levels of concentrations (0, 3, 5 or 7% w/v sucrose), (0, 20, 30 or 50 ppm $AgNO_3$) were tested alone as well as combination. The cut flowers were treated in three stages of maturity [bud (B), half opening (H.O) or complete opening (C.O)]. The pulsing times were 5, 10 or 24 hours, then transferred to distilled water as control. The experiment was laid out in a completely randomized design replicated thrice. The sucrose, 7% and $AgNO_3$ 30% individually recorded higher vase life of 17.2 and 15 days respectively. Whereas, their combinations (sucrose 7% × $AgNO_3$ 30%) was significantly superior to the rest of combination in keeping higher water uptake and retarded the chlorophyll as well as the carbohydrate degradation during the postharvest life and resulting in a highest vase life of 19.1 days.

Keywords- Longevity, Taif rose cut flowers, $AgNO_3$, Sucrose, water uptake, Chlorophyll, carbohydrate

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Introduction

Rose is one of the most popular cut flowers in different countries for highest economic importance in the floricultural industry [1], and a very long vase life compared to other cut flowers [2], which is one of the characteristics demanding in a commercial value of the ornamental flowers. Taif rose have an important role in the national economy for its great value in exportation of its oil to the Arab countries, ornamentation, medicinal use as well as manufacture of perfumes, [3]. Vase life termination for many cut flowers is characterized by wilting [4]. Water balance is a major factor determining quality and longevity of cut flowers. It is influenced by water uptake and transpiration and balance between two mentioned processes [5]. When the amount of transpiration exceeds the volume of water uptake, water deficit and wilting develops [6]. Low water uptake is often due to occlusions located mainly in the basal stem end [4]. Microorganisms are communally cause of stem blockage of xylem vessels which accumulated in the vase solution or in the vessels [7] and result a negative effect on the continuing water uptake and transportation by the leaves of cut flowers and stem tissue [8,9], and finally shortening there vase life [10,11], and reduces water uptake. This blockage of xylem vessels led to water stress, which was expressed in the form of early wilting of leaves or flowers [7]. Pulsing with high concentration of silver nitrate is beneficial in extending the life of many cut flowers like gerberas, gladioli, chrysanthemum carnation and roses [12,13]. Tight carnation buds were opened in 10% sucrose after impregnating the stems for 1 hour in a 1000 ppm $AgNO_3$ solution [12]. Pulsing of cut roses for 10 and 20 min with $AgNO_3$ improved the vase life up to 6.0 and 5.3 days, respectively [14]. Application of $AgNO_3$ significantly increased the vase life as well as the gain fresh weight of rose as compared to 5.3 days in control [15]. Also, sucrose acts as a preservative materials, in addition to extending the vase life of cut flowers [16]. Different concentrations of sucrose ranging from 0 to 7.5% had been investigated by Pun, et al. [17] on cut spray carnation, they found that 5.0 sucrose recorded the best vase life and delayed the climacteric ethylene in petals. Furthermore. Butt, 2005 [18] study the effect of sucrose in different concentrations on two cultivars of *Rosa hybirida* and results showed that sucrose at 25 gL^{-1} extended the vase life by 8.2 days.

On the other hands, sugars with biocides have become an important preservatives for floral several cut flowers [19], and prevented bent-neck of flower stems of {*Cara Mia}* rose cultivar [20]. Butt, [21] reported that when cut roses were treated with sucrose for 16 hours, the treatment increased the soluble sugar content, and reduced both photosynthesis rate and chlorophyll content. However, it stimulated the respiration rate of leaves, as compared with the control [12]. Also Nair, et al [22] study the effect of (Ag NO_3) plus sucrose in different concentration on vase life of gerbera cut flower, the treatment extended the vase life and delaying the head dropping and discoloration.

Material and Methods

Experiment 1

Plant Materials

Cut flowers of Taif roses were used for different trials. The flowers were obtained directly from the commercial grower. The flowering stems were trimmed to a uniform length of 25 cm to flowers at different stages and for different pulsing time. Then a smooth slanting cut were made to flower stem to facilitate the optimum up take of given solutions. Cutting had been done underwater to avoid air embolisms. All leaves on the lower section of the stem were removed. The sample had been divided into 30 groups with five replications, each replication contain one flower (to avoid contamination). They were kept at room temperature 23 $\pm$ 1°C at normal day light and natural ventilation. Flowers had been harvested in three stages" bud stage (B.S), one or two basal flowers open [half opening] (H.O.S), or when they are fully opened (C.O.S)".

Treatment Setting

Treatments were set following a completely randomized design. Each treatment represented by 5 replication.

Chemical Preparation

Chemicals were obtained from a trading company in Saudi Arabia.

Analytically pure Silver nitrate ($AgNO_3$) had been pulsed as follow:

1st Trial: Five hours only for $AgNO_3$ at concentrations of 30, 50, 70 ppm. Then flowers were transferred into 250 ml glass bottle filled with distilled water along the duration of experiment (for the three stages).

2nd Trial: Ten hours only for. $AgNO_3$ at concentrations of 30, 50, 70 ppm. Then flowers were transferred into 250 ml glass bottle filled with distilled water along the duration of experiment (for the three stages).

3rd Trial: Twenty four hours for $AgNO_3$ at concentrations of 30, 50, 70 ppm. Then flowers were transferred into 250 ml glass bottle filled with distilled water along the duration of experiment (for the three stages).

Also analytically pure sucrose had been pulsed as fallow:

1st Trial: Five hours (5h) at concentration of 3%, 5% and 7%. w/v. Then flowers were placed in 250 ml glass bottle containing distilled water, along the duration of experiment (for the three stages).

2nd Trial: Ten hours (10h) at concentration of 3%, 5% and 7%. w/v. Then flowers were placed in 250 ml glass bottle containing distilled water, along the duration of experiment (for the three stages).

3rd Trial: Twenty four hours (24h) at concentration of 3%, 5% and 7%. w/v. Then flowers were placed in 250 ml glass bottle containing distilled water, along the duration of experiment (for the three stages).

Control Treatment

Flowers was trimmed in different stages of maturity and kept in 250ml distilled water along the duration of the experiment, as a control treatment for the different trials.

Vase Life Determination

Visual rating of flowers was carried out on the basis of a scale from 1 to 4 when: 1 = entirely fresh flowers, 2 = initiation of wilting in 20% of petals and beginning of bent neck, 3 = wilting in 20-50% of petals and increasing the bent neck, 4 = wilting in 50-100% of petals.

Experiment 2

Plant Material

The same preparation of plant material mentioned in experiment (1)

Chemical Treatments

($AgNO_3$) + Sucrose Treatments

Silver nitrate ($AgNO_3$ at 30 ppm) was applied for 24 hour depending on the previous results (which the best one), whether with or without sucrose at 7% (w/v) the concentration, which attained the best results in the previous experiment. The two compounds are dissolved in sterilized distilled water in glass bottle containing 250 ml to study the effect of their interaction.

Control Treatment

Flowers are trimmed and kept in 250ml distilled sterilized water along the duration of the experiment, as a control treatment for different experiments.

Vase Life Determination

Vase life of rose cut flowers was measured as mentioned in experiment (1)

Fresh Weight Measurements

Fresh weight determination of the flowers were mad just before the immersion of flowers into the solutions and repeated on the day when the vase life of the control flowers was terminated. The flowers are taken out of solutions after 24 hours pulsing time.

Chlorophyll Determination

Chlorophyll content was measured for the best treatment of each chemical for all cut flowers under study. Chlorophyll content of sepals segments was extracted by methanol and the absorbance was determine by spectrophotometer. This was done on day 0, 5, and on the day when the vase life of the control flowers are terminate. The samples were collected separately from each replicate and the average of the three replicates was calculate. The chlorophyll concentration was calculated as mg l^{-1} fresh weight. The equations for the determination of concentrations of chl. *A* and chl *b* were Chl *a* (mg l^{-1}) = 12.21 A_{663} - 2.81 A_{646} Chl *b* (mg l^{-1}) = 20.13 A_{646} -5.03 A_{663}.

Carbohydrate Determination

Soluble carbohydrate determined on stem of the best treatment of each chemical and the best stage of maturity and best pulsing time, tested in the study. Sample were taken on the same day as mentioned in chlorophyll determination. One flowering stem from each replicate was used. Dried sample were ground together into homogenized powder, using a household crusher (10 mg of oven-dried plant material were extracted by 10 ml of borate buffer (28.63g boric acid + 29.8g KCL + 3.5g NaOH in lL of hot de-ionized distilled water), left overnight, and filtered. Using spectrophotometer to detect the different types of sucrose.

Results and Discussion

Effect of $AgNO_3$ and Sucrose on Vase Life of Taif Rose Cut Flowers

Vase Life- The statistical analysis of results showed that the $AgNO_3$ & sucrose, significantly extended the vase life of Taif rose cut flowers compared to control in different concentrations and different

stages of maturity, [Table-1]. The longest vase life attained at 7% (w/v) sucrose which gave 17.2 days, followed by 15 days for $AgNO_3$ at 30ppm and 7 days for control compared to other concentrations of sucrose and $AgNO_3$ [Table-1]. Carbohydrates are most important compounds in reserve solutions, manly sucrose which sometimes, lonely present in phloem sap. Cut flowers senescence is initiated when energy required for synthesis reactions is considerably reduced. Therefore exogenous application of sucrose would be helpful in delaying senescence by maintaining the structure and activity of mitochondria [23]. Also sucrose act as food source or respiratory substrate and delays the degradation of proteins and improves the water balance of cut flowers [24]. While, Steinitz [25] opined that addition of sucrose to the solution increased the mechanical rigidity of the stem by inducing cell wall thickening and lignifications of vascular tissues. Also $AgNO_3$ is an effective inhibitor of ethylene biosynthesis [26] and act as bactericides [27]. Our results in confirm the results obtained by other researchers [28] and [29] they opined that $AgNO_3$ prevented microbial occlusion of xylem vessels in Dendrobium, thereby enhancing water uptake and increasing longevity of flowers. Awad, et al [30] also attributed the beneficial effect of $AgNO_3$ in the vase water to the production of Ag^+ ions, which might inhibit the rise of ethylene precursor thereby enhancing longevity of cut flowers.

Table 1- Effect of $AgNO_3$ and sucrose on vase life of Taif rose cut flowers

Treatments	Vase life after different Pulsing time / hours								
	B			H.O			C.O		
	5h	10h	24h	5h	10h	24h	5h	10h	24h
$AgNO_3$ 30 ppm	11.8	14.5	13.8	11	13	15	8.8	12.4	12.8
$AgNO_3$ 50 ppm	11.8	14.5	12.8	10.2	13.4	13.8	9	12	13. l
$AgNO_3$ 70 ppm	10.8	11.6	12.2	10.8	13.2	13.2	7.6	9.6	11.8
Sucrose 3%	9.4	11.6	12.6	13.2	14	13.8	11.6	13.4	13
Sucrose 5%	10.2	11p	11p	13.8	13	14.2	12.2	14.6	15.8
Sucrose 7%	12.4	12	13.2	13.2	14.3	17.2	14.5	13.8	13
Control		4*			7*			6*	

Stages of Maturity

Depending on results of [Table-1], the (H.O.S) stage result in the highest longevity compared to different stages, these data are consistent with the hypothesis that, smaller buds of cut flowers may abort for lack of carbohydrate [31], similar results obtained by van Meetern, et al [32] in lilies cut flowers, thereby the lack of carbohydrate has been shown to lead to increased ethylene biosynthesis and bud abortion [33], which are consistent with this suggestion. Curiously, supplying added carbohydrate did not consistently reduce ethylene production in very yang buds. They may have insufficient sink strength to compete with expending buds for carbohydrate provide from the vase solution [Table-1], thereby short vase life in flowers had been cut in bud stages compared to other stages [Table-1], may be due to leaching of carbohydrate as reported by Vander Muisers, et al [34] in Asiatic lily, while the flowers cut in complete opening stage import more carbohydrates from the leaves and stem than that taken in H.O.S [19], which in agreement of the results of [Table-1].

Pulsing Time

The results of [Table-1] showed that the 24h pulsing time in preservative solution attained good results compared to other pulsing times, which in agreement of the recommendation of Halevy and Kofranek [35] when he pulsed Lisianthus flower in 6% sucrose for 24h the postharvest life had been improved and flower opening considerably increased [36].

The Combination Effects of $AgNO_3$ and Sucrose on Vase Life and Postharvest Quality of Taif Rose Cut Flowers

Vase Life- Sucrose or $AgNO_3$ alone was less effective as compared to their combinations with regard to vase life. When 7% sucrose was added to 30ppm $AgNO_3$ the vase life was extended to 17.8, 19.1 and 13.9 days for (B), (H.O) and (C.O) stages respectively compared to 9.9, 10.5 and 8.9 days without sucrose for the same mentioned stages, [Table-2], through 24h depending on results of [Table-1]. This may be due to the nutrient effect of sucrose [37] and antibacterial effect of $AgNO_3$ [38]. Further more when added $AgNO_3$ to sucrose may suppress autocatalytic ethylene production by inhibiting ethylene action [39], so that the two compound prevent the xylem blockage witch lead to promote water uptake by stem and finally result in a good vase life, similar results by Ohkawa, et al [38].

Table 2- Effect of the best treatment of $AgNO_3$ and sucrose on vase life and postharvest quality of Taif rose cut flowers

Treatments	Vase life after different Pulsing time / hours		
	B	H.O	C.O
$AgNO_3$ 30 ppm	13gf	15d	12h
Sucrose 7%	13gf	17b	14e
$AgNO_3$ 30 ppm 7% sucrose	17.8bc	19.1a	13.9f
Control	4k	7j	6ji

**Different letters explain the significant differences between means, according to Duncan multiple range p = 5.05.*

Chlorophyll Content

The previous treatments lead to a considerable delay in degradation of Chl *a* and Chl *b* compared to control [Table-3], [Table-4] and [Table-5]. The concentration of chlorophyll *a* was higher than chlorophyll *b* at any point of time throughout the vase life. [Table-3], [Table-4] and [Table-5].

Table 3- Effect of $AgNO_3$ with or without sucrose and sucrose compared to control on chlorophyll content for Taif rose cut flowers in bud stage. (unit was mgl^{-1} fresh weight).

Treatments	Days of determinations of chl. *a* and chl. *b*					
	1st day		6th day		10th day	
	Chl. *a*	Chl. *b*	Chl. *a*	Chl. *b*	Chl. *a*	Chl. *b*
$AgNO_3$ 30 ppm	0.66	0.19	0.86	0.20	0.17	0.05
$AgNO_3$ 30 ppm + sucrose 7%	0.93	0.21	0.79	0.17	0.20	0.04
Sucrose 7%	0.97	0.29	0.64	0.18	0.15	0.04
Control	0.13	0.06	0.54	0.14	0.48	0.28

Table 4- Effect of $AgNO_3$ with or without sucrose and sucrose compared to control on chlorophyll content for Taif rose cut flowers in half opening stage. (unit was mgl^{-1} fresh weight).

Treatments	Days of determinations of chl. *a* and chl. *b*					
	1st day		6th day		10th day	
	Chl. *a*	Chl. *b*	Chl. *a*	Chl. *b*	Chl. *a*	Chl. *b*
$AgNO_3$ 30 ppm	0.79	0.29	0.25	0.03	0.24	0.03
$AgNO_3$ 30 ppm + sucrose 7%	1.34	0.46	0.75	0.14	0.19	0.07
Sucrose 7%	0.50	0.13	1.10	0.32	0.09	0.05
Control	0.65	0.19	0.15	0.03	0.09	0.02

The data show that there was a positive role for sucrose with or without $AgNO_3$ on preserving the flowers in good condition by inhibiting the chlorophyll retention. Similar results were obtained by Tjosolved, et al [40] and Serek, et al [41], Chatterjee, et al [42], and Singh and Tiwari [26].

Table 5- Effect of $AgNO_3$ with or without sucrose and sucrose compared to control on chlorophyll content for Taif rose cut flowers in complete opening stage. (unit was mgl^{-1} fresh weight).

Treatments	Days of determinations of chl. *a* and chl. *b*					
	1st day		6th day		10th day	
	Chl. *a*	Chl. *b*	Chl. *a*	Chl. *b*	Chl. *a*	Chl. *b*
$AgNO_3$ 30 ppm	0.51	0.14	1.05	0.58	0.08	0.02
$AgNO_3$ 30 ppm + sucrose 7%	0.40	0.08	1.08	0.35	0.31	0.11
Sucrose 7%	0.54	0.15	0.44	0.13	0.19	0.05
Control	0.42	0.13	0.37	0.12	0.07	0.03

[1]mg 1^{-1} fresh weight for different stage.

Carbohydrate Content

Data of [Table-6], [Table-7], [Table-8] and [Table-9] showed that fructose, glucose and sucrose were the main soluble carbohydrates in petals and stems of Taif cut roses. Fructose was the major component in the petals as well as in stems but, generally, its value was higher than in stems. Sucrose contents in petals and stems were lower than those of glucose. The carbohydrate content significantly increased as a result of using 30ppm $AgNO_3$ + 7% sucrose till the 5th day then sharply decreased on the 12th day at which the vase life of control was terminated. While stem contents of the previous sugars increased at the beginning of the experiment, then decreased towards the end of the experiment compared to control [Table-6]. Pulsing for 24h may enhanced total starch contents of petals as well as compared to untreated cut rose flowers [43]. These results were coincided with those obtained by Zagory and Reid [44] on many cut flowers, on bird of paradise [45], cut rose flowers, [46], chrysanthemum, [47], freesia, [48] on gladiolus cut flower spikes, [49] and tuberose cut flowers spikes [50].

Table 6- Effect of $AgNO_3$ with or without sucrose and sucrose on carbohydrates content for petals of rose cut flowers in bud stage.

Treatments	Days of determination of carbohydrate contents								
	1st day			5th day			12th day		
	G	F	S	G	F	S	G	F	S
$AgNO_3$ 30 ppm	8.08	9.63	1.55	7.03	8.65	1.92	4.89	5.57	0.68
$AgNO_3$ 30 ppm + sucrose 7%	7.39	8.04	0.65	5.01	6.78	1.77	6.84	7.39	0.55
Sucrose 7%	5.08	6.08	1.81	9.57	10.38	0.81	8.88	9.25	0.37
Control	9.78	10.64	0.86	9.76	11.14	1.39	6.38	9.71	3.33

F: Fructose G: Glucose S: Sucrose (in different tables)

Table 7- Effect of $AgNO_3$ with or without sucrose and sucrose on carbohydrate content for stem of rose cut flowers in bud stage.

Treatments	Days of determination of carbohydrate contents								
	1st day			5th day			12th day		
	G	F	S	G	F	S	G	F	S
$AgNO_3$ 30 ppm	4.55	6.55	2.01	3.86	3.99	0.13	5.08	6.88	1.81
$AgNO_3$ 30 ppm + sucrose 7%	6.58	7.23	0.66	7.27	7.46	0.19	5.52	6.11	0.59
Sucrose 7%	5.18	6.89	1.71	3.07	3.26	0.19	3.48	4.09	0.61
Control	5.05	5.65	0.61	6.28	7.92	1.64	5.68	6.05	0.38

Table 8- Effect of $AgNO_3$ with or without sucrose and sucrose on carbohydrates content for petals of rose cut flowers in half opening stage.

Treatments	Days of determination of carbohydrate contents								
	1st day			5th day			12th day		
	G	F	S	G	F	S	G	F	S
$AgNO_3$ 30 ppm	3.55	5.55	2.01	3.86	2.99	0.13	4.08	6.88	1.81
$AgNO_3$ 30 ppm + sucrose 7%	5.84	7.23	0.66	7.83	8.17	0.36	8.34	10.54	2.21
Sucrose 7%	4.88	5.89	1.71	10.95	12.07	1.12	2.68	4.09	0.61
Control	5.05	5.65	0.61	7.79	8.62	0.83	9.81	12.21	2.41

Table 9- Effect of $AgNO_3$ with or without sucrose and sucrose on carbohydrate content for stem of rose cut flowers in half opening stage.

Treatments	Days of determination of carbohydrate contents								
	1st day			5th day			12th day		
	G	F	S	G	F	S	G	F	S
$AgNO_3$ 30 ppm	4.11	5.32	1.21	5.67	6.52	0.85	3.81	4.84	1.03
$AgNO_3$ 30 ppm + sucrose 7%	4.99	6.23	1.29	4.69	5.92	1.23	6.07	7.49	1.42
Sucrose 7%	7.43	9.78	2.35	4.69	4.92	1.23	10.46	11.07	0.61
Control	5.95	6.45	0.51	7.79	8.62	0.83	9.81	12.21	2.41

Table 10- Effect of $AgNO_3$ with or without sucrose and sucrose on carbohydrates content for petals of rose cut flowers in complete opening stage.

Treatments	Days of determination of carbohydrate contents								
	1st day			5th day			12th day		
	G	F	S	G	F	S	G	F	S
$AgNO_3$ 30 ppm	5.43	7.68	2.25	4.69	5.92	1.23	7.09	7.81	0.72
$AgNO_3$ 30 ppm + sucrose 7%	5.98	6.28	031	8.86	9.11	0.25	7.39	10.51	3.12
Sucrose 7%	5.95	6.87	0.92	8.83	9.45	0.62	9.38	9.99	0.61
Control	3.86	4.17	0.31	9.45	10.06	0.61	9.91	11.55	1.64

Table 11- Effect of $AgNO_3$ with or without sucrose and sucrose on carbohydrate content for stem of rose cut flowers in complete opening stage.

Treatments	Days of determination of carbohydrate contents								
	1st day			5th day			12th day		
	G	F	S	G	F	S	G	F	S
$AgNO_3$ 30 ppm	6.46	7.73	1.27	4.86	5.83	0.97	4.93	5.82	0.89
$AgNO_3$ 30 ppm + sucrose 7%	7.14	8.63	1.49	5.95	6.68	0.75	6.39	9.5	2.12
Sucrose 7%	4.65	5.97	1.32	6.04	7.67	1.63	4.67	5.92	1.25
Control	6.05	6.96	0.91	9.45	10.06	0.61	9.91	11.55	1.64

Conclusion

A significant improvement in vase life of Taif rose cut flowers was occurred when treated with 30ppm $AgNO_3$ and the effect was further improved when $AgNO_3$ at 30 ppm combined with 7% (w/v) sucrose which attained the best result compared to other concentrations of sucrose. Also chlorophyll and carbohydrate had been retarded during the postharvest life as the result of using this combination treatment which they represent one of the more important parameters of good performance of postharvest physiology of cut flowers.

Conflicts of Interest: None Declared.

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