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Effect of Ni, CO, SA and Sucrose on Extending the Vase-Life of Lily Cut Flower

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Abstract: In this research, the effect of different concentrations of Nickel (0, 1.5 and 2.5 mM), Salicylic acid (0, 1 and 2 mM), Cobalt (0, 1 and 2 mM) and sucrose (0, 2.5%) on flower longevity, Acc-oxidase activity, anthocyanin leakage, microbial population, water uptake and SPAD value as a measure of leaf greenness of Lily was investigated. To evaluate the effect of these treatments, a study was carried out based on the randomized complete design with five replications. Results of this experiment showed that the best treatment in extending the longevity of the flowers were solutions containing 2 mM SA, 2 mM SA+ 2.5% sucrose and 2.5mM Ni+ 2 mM SA+2 mM Co with 2.5% sucrose. SA, Ni and Co decreased the anthocyanin leakage, whereas the highest concentrations of SA, Ni and Co reduced ACC-oxidase activity. The Maximum of chlorophyll content was observed for flower kept in solution containing 2 mM SA and 2 mM SA+ 2.5% sucrose compared to the control and solution containing Ni and Co. Ni and Co treatments had no positive effect on increasing the water uptake and fresh weight of Lily. Overall, the results suggest that SA, Ni, CO and sucrose increase the vase-life by improving the membrane stability and reducing the oxidative stress damages during Lily flower senescence.

Key words: Lily; Nickel; Salicylic acid; Cobalt; Vase-life
Abbreviations: Ni, Nickel; Co, Cobalt; SA, salicylic acid; ACO, ACC-Oxidase

INTRODUCTION

Vase-life of cut flower is most attractive and economic component of cut flower [1]. The main problems of ornamental perishables usually are flowers or leaf senescence [2]. During senescence marked changes occur in the biochemical and biophysical properties of the cell membranes. Ethylene plays a central role in the senescence of many cut flowers [3]. The postharvest quality of many flowers is reduced by ethylene. Ethylene causes premature wilting, color fading, abscission of flower petals and leaf yellowing [4, 5]. The effects of senescence can be reduced by inhibitors of ethylene biosynthesis [6-9]. SA is a phenolic compound that acts as a potential non-enzymatic antioxidant as well as a plant growth regulator, which plays an important role in regulating a number of plant physiological processes including photosynthesis [10-12]. A correlation between the antioxidant enzyme activities and SA concentrations explored that Co and Ni inhibit the conversion of ACC to ethylene in various tissues [13-15]. Jamali and Rahemi [16] reported that treatment with Co and Ni significantly extends the vase-life carnation. Ni is an anti-ethylene feature and can impede ethylene production [17]. The postharvest life of flowers is strongly dependent on the carbohydrate status and the acceptable amount of metabolic sugars is a factor that affects the rate of senescence. Therefore, an exogenous carbohydrate supplementation would be enough to delay the senescence, considering that the main effect would be to maintain the structure and activity of the mitochondria. Therefore, in this study, the preservative effects of SA, Ni, Co and sucrose and their interaction on the vase-life of cut Lily flowers were studied.

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MATERIALS AND METHODS

Plant Material: 'Prato' Lily was harvested in half-open stage from local commercial greenhouses (Mahallat, Arak, Iran), in the morning and transported with appropriate covers immediately. Cut flower stems of 'Prato' Lily were placed in solution containing Ni (0, 1.5 and 2.5 mM), SA (0, 1 and 2 mM), Co (0, 1 and 2 mM) and sucrose (0, 2.5%) after cutting. Distilled water was used as control then the samples were placed in chambers at 19°C with relative humidity of about 70% and 14h photoperiod was maintained using fluorescent lamps with a light intensity of 15 µmol m^{-2} s^{-1} at the top of the corolla.

Vase-Life: Vase-life was determined as the number of days to wilting of flowers. The flowers were checked once a day for signs of deterioration.

Chlorophyll Content Measurement: Total chlorophyll (a+b) content was measured by chlorophyll meter (SPAD-502, Minolta Co. Japan) which is presented by SPAD value. Average of 3 measurements from different spots of a single leaf was considered.

Determination of ACC-Oxidase Activity: ACC-oxidase activity was measured based on the method of Moya-Leon and John [18].

Determination of Anthocyanin Leakage: Anthocyanin leakage was measured based on the method of Poovaiah [19].

Microbial Population: Test microbial populations were isolated from vase solutions of Lily by the method described by Zagory and Reid [20].

Water Uptake and Fresh Weight: The volume of water uptake was calculated by subtracting the volume of water evaporated from a control bottle without cut flowers from the amount of water decreased in bottles containing flowers. The fresh weight of the cut flowers also measured in initial day and terminal day of experiment.

Experimental Design and Statistical Analysis: Experiment was arranged in a factorial test based on complete randomized design with five replications. Analysis of variance was performed on the data collected using the general linear model (GLM) procedure of the SPSS software (Version 16, IBM Inc.). The mean separation was conducted by tukey analysis in the same software (p= 0.05).

RESULTS AND DISCUSSION

Cut flowers which were held in control had the shortest vase-life compared to the cut flowers in the other treatments ($p \leq 0.05$). Flowers treated with 2.5mM Ni, 2 mM SA and 2 mM Co with 2.5% sucrose proved to be better treated for extending the longevity compared to the other treatments (Table 1). Combinations of Ni, SA, Co and sucrose were found to be significantly and positively correlated with vase-life of the Lily cut flowers as well ($p \leq 0.05$, Table 1). Our results are similar to Kazemi and Shokri, [2] and Kazemi *et al.* [13-15]. Jamali [16] reported that treatment with Ni and Co significantly extends the vase-life carnation. The combination of 2.5 mM Ni, 2 mM SA, 2 mM Co with 2.5% sucrose was the best treatment because of its ability to extend the vase-life up to 18 days. Ni, SA and Co significantly decreased the anthocyanin leakage and ACO activity compared to the cut flowers that were treated by sucrose and the control ($p \leq 0.05$, Table 1). Sucrose caused no positive effect or had a positive effect on decreasing the anthocyanin leakage and ACO activity. On the other side, highest activities of ACO were found in cut flowers treated with control. The interaction between Ni, SA and Co on ACO activity was significant (Table 1). These findings are in agreement with those reported by [21, 22, 2]. The maximum of chlorophyll content was observed in flower kept in solution containing 2 mM SA and 2 mM SA+ 2.5% sucrose compared to the control and solution containing Ni and Co. Flower chlorophyll content only in solution containing 2 mM SA and 2 mM SA+2.5% sucrose had significant difference ($P<0.05$) compared to the control and others didn't show that much difference (Table 1). The results indicated that 2 mM SA and 2.5% sucrose and their combination caused a significant increase in SPAD value ($p \leq 0.05$). Application of SA and sucrose caused a significant increase in chlorophyll index, while Ni and Co alone had no significant effect. SA and sucrose caused an increase in water uptake, while Ni and Co alone were not effective significantly ($p \leq 0.05$). Uptake rate decreased rapidly in distill water while flowers in the solutions containing 2 mM SA and 2.5mM Ni, 2 mM SA, 2 mM Co with 2.5% sucrose showed the minimum decrease in water uptake rate from the day 15th and 18th (Table1). Interaction of SA with Ni and Co had significant effect on water uptake and microbial population ($p \leq 0.05$). SA, Ni and Co caused a linear reduction in the colony count. 2 mM SA and 2.5mM Ni+2 mM SA+2 mM Co decreased the colony count significantly from 66 cfu ml^{-1} to around 15 cfu ml^{-1}. SA is a well known phenolic compound that can prevent the ACC-oxidase activity that is the direct precursor of

Table 1: Mean comparisons of chlorophyll content, vase-life and ACC-oxidase activity in Ni, Co,SA and sucrose and their interaction

Ni (mM)	Co (mM)	SA (mM)	SUC %	Vase-life (day)	Total chlorophyll (SPAD reading)	ACC-oxidase activity (nmol h^{-1} ml^{-1})	Water uptake (ml per flower)	Colony count (cfu ml^{-1})	Antocyanin leakage (absorption at 525 nm)
0	0	0	0	7	1.8	85	55	66	168.1
			2.5	9	4.04	80	80	59	100.12
		2	0	15	6.5	32	125	15	38.14
			2.5	15	8.7	61	100	32	87.12
	2	0	0	9	2.31	41	70	46	51.12
			2.5	10	2	55.1	80	50	66.45
		1	0	10	2.31	50.47	85	42	49
			2.5	10	2.07	50.01	85	47	55.17
		2	0	13	3	30.54	80	40	50.21
			2.5	13	2.87	45.7	80	53	63.2
1.5	2	0	0	10	2.36	30.14	85	46	50.02
			2.5	12	3.14	50.36	85	52	59.41
		1	0	11	2.14	30	80	40	49.11
			2.5	11	2.36	50.68	80	48	55.07
		2	0	13	2.78	27.15	90	30	43.11
			2.5	13	3	36.98	95	46	49.78
2.5	0	0	0	13	3	30.7	90	36	42.36
			2.5	14	3	45.78	95	42	50.36
		2	0	15	3.14	28.01	100	30	40.12
			2.5	15	3.15	68.9	110	38	49.63
	2	0	0	14	3	40.12	95	35	40.11
			2.5	15	2.91	46.53	100	38	45.36
		1	0	14	3.15	37.12	95	28	41.41
			2.5	14	3	40	105	31	46.98
		2	0	16	3.9	30	115	15	30.08
			2.5	18	4.5	42.31	125	22	41.36
F-test probabilities									
Ni					0.07	0.03	0.05	0.05	0.04
Co					0.06	0.04	0.051	0.05	0.04
SA					0.001	0.001	0.001	0.01	0.01
SUC					0.03	0.06	0.04	0.02	0.077

ethylene and decrease ROS with increase of enzyme antioxidant activity [23-26]. Canakci [26] reported that treatment with salicylic acid significantly extends the vase-life and also increases the total chlorophyll content. Ions of Ni have an inhibitory effect on ACC-oxidase by forming an enzyme-metal complex [27, 28]. Inhibitory effect of Ni on ethylene makes this element a good choice for improving the postharvest life of horticultural crops especially cut flowers because there is no concern about Ni accumulation at toxic levels in carnation cut flowers [16], also Co can impede the production and accumulation of ethylene. Therefore, in this study, our results showed that addition of SA, Ni, Co and sucrose have positive correlation with vase-life of the Lily cut flower.

CONCLUSION

From the present study it was concluded that SA, Ni, CO and sucrose can influence on the vase- life, water uptake, fresh weight and chlorophyll content of Lily. We found that higher vase-life could be obtained when SA, Ni, Co and sucrose were applied to the preservative solution. The results of the present experiment showed that SA, Ni, CO and sucrose could affect on flower vase-life and alleviated the senescence.

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