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The Effect of Cola on Postharvest Physiological Characteristics of Cut *Alstroemeria*

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Abstract

The present study has assessed the effect of Cola in increasing flower longevity of flower and delaying aging of cut *Alstroemeria* 'Balance'. Distilled water was used as control. Traits of flower diameter, solution absorption ,anthocyanins, total soluble solids and chlorophyll were measured at 3 times and vase life was measured daily. Based on the results, flower diameter, anthocyanins and chlorophyll were significant at 1% level and solution absorption was significant at 5% level. The highest flower longevity was related to concentration 500 ml L^{-1} Cola with 16 days, while the control was 9 days. The highest solution absorption rate belonged to 250 ml L^{-1} treatment of Cola. Cola concentration of 375 ml L^{-1} had the greatest flower diameter and chlorophyll. According to the results of means comparison, amount of anthocyanin in different concentrations of Cola was the same. In general, Cola delayed aging *Alstroemeria* flowers due to having compounds such as citric acid, phosphoric acid, sugar, sodium benzoate, etc., and by providing flowers with required carbohydrates and antimicrobial effect.

Keywords: *Alstroemeria*, Cola, Vase life.

INTRODUCTION

In recent years, using natural compounds in the control of bacterial, yeast and fungus infections and reduction of wastes after harvesting horticultural products such as cut flowers has been proposed. Because most chemicals are toxic and cause environmental pollution, using natural compounds that have no adverse effects on human and environment and are relatively inexpensive is of great importance (Okigbo and Ikediugwn, 2005). Most natural compounds that have been studied for this purpose were essences and extracts of medicinal plants, but using Cola and some fruit juices, due to having specific compounds as can be studied and experimented as cut flowers preservative solutions, but they have rarely been investigated of course it has been already recommended use Cola.

Ebrahimzadehand Seifi (1999) offered compound of 250-500 ml L^{-1} sevenup and half a teaspoon bleach along with water as a simple and affordable solution. Cola are made up of materials such as citric acid, sucrose, carbon dioxide, sodium benzoate, etc. These drinks, due to containing citric acid and phosphoric acid, have pH range of 2.9-3.8. Appropriate pH for preservative solution of cut flowers is 3.5 to 4.5 (Edrisi, 2009). Water used in the vase solution must have least hardness and microorganisms. One of features of Cola that makes it suitable for vase solution is the features of water used in it. For producing Cola, water hardness and microorganisms are removed through the use of disinfectants and deionizers.

Sucrose has been used to extend the life of various types of flowers (Asadi *et al*., 2010; Emamian and Mortazavi, 2010; Khalighi and Shafie, 2000; Kazemi *et al.*, 2010). Sucrose regulates transport of water and minerals within the vessels by controlling transpiration (Capdeville *et al.*, 2003). Amount of sugar in Cola is about 10%. If sucrose is put the vase solution alone, causes growth of microorganisms. Using a germicidal agent along with sucrose in preservative solutionis always recommended (Mir Saeed Qazi *et al.*, 2013). In addition to containing sugar, due to having compounds such as citric acid and phosphoric acid, Cola provides suitable pH for cut flowers.

In the research by Mortazavi and Elahi (2011), it was found that treatment of carnation cut flowers to75 mg L^{-1} of citric acid increases solution absorption and vase life. Reddy *et al.,* (1995) tested compound of 100 mg L^{-1} citric acid with 4% sucrose for tuberose, that led to improved water absorption and flower longevity to 16 days.

Alstroemeria belongs to Amarilidaceae family and it is one of the worlds important cut flowers. It has many applications due to having various colors.

The aim of conducting this study is to investigate the possibility of replacing simple compounds such as Cola as and determine its best concentration in preservative solutions of cut flowers in order to increase vase life of cut *Alstroemeria*.

MATERIALS AND METHODS

This experiment was performed in Laboratory of Horticultural Sciences Department, Gorgan University of Agricultural Sciences and Natural Resources in April 2014. In this study, *Alstroemeria* flowers were prepared from Azin Behesh greenhouse in Isfahan. The temperature of vase life room was 2 ± 24°C, relative humidity 5 ± 60% and light intensity was 850 lux. Flowers were cut open as 30 cm of length and put into containers with 500 ml of preservative solution. Thise xperiment was conducted in a completely randomized design with factorial arrangement in three replications and each replication consisted of 3 flowers. The treatments used was commercial Cola at 4 levels (0, 250, 375, 500 ml L^{-1}). Parameters of flower diameter, solution absorption, dissolved solids, anthocyanin and chlorophyll were measured in 3 stages (days 3, 6 and 9), and flower longevity was measured daily. Vase life was calculated as flower wilting per day. The flowers were examined daily for observing signs of wilting. Chlorophyll content of leaf was gauged through chlorophyll meter model Hansatech CL-01.Water absorption was measured by dipping the volume of the solution and diameter of Floret using a digital caliper. To measure the petal anthocyanins,

Vangr method(1979) was used and for measuring wet weight digital scale was used and was finally expressed using the following formula (Pompodakis *et al*., 2005).

$FW= (S_{t-1})-S_t /w_t = 0)$

In this formula, the symbols listed are as follows.

FW: Absorbed solution

S_t: Weight of solution (g) in days 0,3 and ...

S_{t-1}: Weight of solution (g)in previous day

$W_t = 0$: Wet weight of shoot in day 0

RESULTS AND DISCUSSION

Flower diameter

Based on analysis of variance, effect of treatment, time and interaction effects of treatment and time was significant at the 1% level (Table 1).

Concentration Cola as 375 ml L^{-1} made the greatest flower diameter and the lowest value was related to the control (Table 2). Also the highset flower diameter was obtained on the sixth day of measurement (Table 3). Sucrose, as a source of carbohydrates, compensates for the shortage of sugars consumed by breathing (Erin *et al*., 2002). It seems that Cola's sugar, which is a kind of sucrose, has provided the energy needed for expansion of florets in *Alstroemeria* vase solutions and increased flower diameter.

Solution absorption

According to ANOVA, the effect of treatment and time on preserving solution's absorption was significant at 5% and the interaction effect of treatment and time was significant at 1%. Results showed that the highest rate of solution absorption belonged to treatment 250 ml L^{-1} Cola (Table 2). Also, the highest rate of solution absorption was obtained on sixth day of measurement (Table 3).

By increasing concentration, the absorption rate of solution decreased. In the research by Reddy *et al*., (1995) on tuberose, the combined treatment of 100 mg l^{-1} citric acid and 400 mg l^{-1} hydroxyqueinoline sulfate and sucrose 4% increased flower longevity and water uptake by flowers.

It can be concluded that citric acid, by providing suitable pH and reducing number of bacteria, increases water uptake by flowers treated by Cola compared to the control.

Table 1. Analysis of variancetheeffect oftreatment and timeonqualitytraitsof cut *Alstroemeria.*

S.O.V	df	Flower diameter (mm)	Solution absorbs (ml. g F.W.)	TSS (%)	Anthocyanin (mg 100 g^{-1} F.W)	Chlorophyll (mg g^{-1} F.W.)
treatment	3	6397.67**	1.71*	15.75**	0.006**	25.9**
time	2	16827.79**	2.3*	63.92**	0.04**	10.37**
treatment*time	6	3014.66**	2.99**	2.66**	0.001*	1.64 ^{ns}
error	24	2.83	140.46	0.17	0.0002	0.29
cv(%)		6.35	16.6	4.09	8.69	6.46

ns:Nonsignificant,*:Significantat5%,** Significantat 1%

Table 2. Mean comparison the effect treatment on vase life and quality traits cut *Alstroemeria.*

Treatment	Flower diameter (mm)	Uptake solution (ml. g F.W.)	TSS (%)	Anthocyanin (mg 100 g^{-1} F.W)	Cholorophyl (mg g^{-1} F.W.)	Vase life (days)
S1	28.23^{b}	3.23^{a}	11.53^{a}	0.21^{a}	9.04^{a}	14.33^{b}
S2	30.85^{a}	3^{a}	10.46^{b}	0.21^{a}	9.39^{a}	14.33^{b}
S3	27.34^{b}	2.46^{b}	9.95^{c}	0.2^{a}	9.12^{a}	16^{a}
C	19.55^{c}	2.31^{b}	8.35^{d}	0.15^{b}	5.8^{b}	9^{c}

In each column, means with the similar letters are not significantly different at1% level of probability using LSD test
S1: 250 ml L^{-1} , S2: 375 ml L^{-1}, S3: 500 ml L^{-1}, C: Control

Table 3. Mean comparison the effect time on vase life and quality traits cut *Alstroemeria*.

Time (Day)	Flower diameter (mm)	Uptake solution (ml. g F.W.)	TSS (%)	Anthocyanin (mg 100 g^{-1} F.W)	Cholorophyl (mg g^{-1} F.W.)
3	21.21[b]	3.25[a]	7.47[c]	0.12[b]	9.1a
6	35.85[a]	2.59[b]	10.88[b]	0.23[a]	8.61b
9	22.41[b]	2.42[b]	11.87[a]	0.22[a]	7.3c

In each column, means with the similar letters are not significantly different at1% level of probability using LSD test

Table 4. Analysis of variance the effect vase life of cut *Alstroemeria.*

S.O.V	df	vase life (days)
Treatment	3	27.86**
error	8	0.16
cv		3.04

** Significantat 1%

Total solution solids (TSS)

The results showed that effect of treatment, time and interaction between treatment and time on amount of TSS of petal was significantat 1%. Table 2 shows that the highest rate of TSS belonged to 250 ml L^{-1} concentrations of Cola and the lowest to the control treatment. On the sixth day highest rate of TSS were obtained (Table 3).

Because of its high sugar, Cola increase solube solids. Also, due to other ingredients such as citric acid and phosphoric acid in Cola that because of the role they play in improving water absorption and delayed wilting, it is able to maintain carbohydrates. Ichimura et al.(2005) consider higher dissolved carbohydrate content in petals of rose, 'Delilah' as the reason for its more flower longevity .

Anthocyanin

ANOVA related to anthocyanins showed that effect of treatment and time at 1% and interaction effect of treatment and time at the 5% was significant (Table 1). Means comparison showed that there was no significant difference between treatments (Table 2). The highest rate of anthocyanin belonged to concentration 250 ml L^{-1} (Table 2).

Colorless is a common symptom in many old flowers. Carotenoids and anthocyanins are two main of flowers pigments. Anthocyanins show greater stability in acidic pH compared to alkaline pH (Edrisi, 2009). Cola with pH 3 above 3 leads to satability in *Alstroemeria* of anthocyanin flower petals. Also, dyes in black Cola may influence the color of the petals.

Chlorophyll

Effect of treatment and time were significantat 1%, but interaction of treatment on time did not have significant difference. Table 2 shows the results of comparing means of chlorophyll, the highest and lowest levels of chlorophyll were related to 375 ml L^{-1} concentration of Cola and the control, respectively and maximum chlorophyll was observed at first stage (Table 3). Alstromeria is one of flowers that are very sensitive to ethylene (Ebrahimzadehand Seifi, 1999).Yellowness of *Alstroemeria* leaves after harvest is related to early aging, which is one of problems of *Alstroemeria* (Mutui *et al*., 2001). Results of the study by Hamidi Imani *et al*. (2012) showed that sodium benzoate with concentration of 250 mg L^{-1}, reduced ethylene production. It seems that sodium benzoate in Cola may some what inhibit ethylene synthesis and prevents leaves yellowing and contributes to the maintenance ofchlorophyll in leaves.

Table 5. Mean comparison the interaction effect treatment and time on flower diameter, solution uptake and TSS of cut *Alstroemeria.*

Flower diameter (mm)					Solution Absorption (ml. g F.W.)				TSS (%)			
Time (Day)	S1	S2	S3	C	S1	S2	S3	C	S1	S2	S3	C
3	18.71^{c}	28.6^{b}	20.78^{c}	16.77^{c}	2.77^{ab}	4.01^{a}	4.11^{a}	2.11^{bc}	7.5^{d}	7.2^{d}	8.3^{cd}	6.9^{d}
6	40.86^{a}	40.52^{a}	37.38^{a}	24.66bc	3.46^{ab}	2.67^{ab}	2.46^{b}	2.71^{ab}	13.1^{a}	11.8^{ab}	13.9^{a}	9.46^{c}
9	25.14^{b}	23.43^{bc}	23.86^{bc}	17.24^{c}	3.46^{ab}	2.33^{b}	0.82^{c}	2.11^{bc}	10.8^{bc}	10.86^{bc}	12.4^{a}	8.7^{cd}

In each column, means with the similar letters are not significantly different at1% level of probability using LSD test.
S1: 250 ml L^{-1} , S2: 375 ml L^{-1}, S3: 500 ml L^{-1} , C: Control

Table 6. Mean comparison the interaction effect treatment and time on Anthocyanin and cholophyl cut *Alstroemeria.*

Anthocyanin (mg 100 g^{-1} F.W)					Cholorophyl (mg g-1 F.W.)			
Time(Day)	S1	S2	S3	C	S1	S2	S3	C
3	0.14^{bc}	0.11^{bc}	0.14^{bc}	0.09^{c}	9.5^{a}	9.78^{a}	9.55^{a}	7.58^{b}
6	0.25^{a}	0.26^{a}	0.25^{a}	0.2^{ab}	9.23^{ab}	9.61^{a}	9.35^{a}	6.25^{b}
9	0.23^{a}	0.24^{a}	0.23^{a}	0.16^{b}	8.39^{ab}	8.78^{ab}	8.45^{ab}	3.58^{c}

In each column, means with the similar letters are not significantly different at1% level of probability using LSD test.
S1: 250 ml L^{-1} , S2: 375 ml L^{-1}, S3: 500 ml L^{-1} , C: Control

Vase life

ANOVA related to vase life of *Alstroemeria* showed that treatment effect was significant at 1%, (Table 4). The highest flower longevity belonged to concentration 500 ml L^{-1} of Cola with 16 days. This is while the control had 9 days of life (Table 2)

Compounds such as sodium benzoate, citric acid, sulfuric acid and sugar in Cola improve the quality traits of flowers after harvest and consequently increase vase life. Results of research by Oraei *et al*., (2011) showed that the concentration of 250 mg l^{-1} sodium benzoate increased vase life of gerbera flower that is consistent with results of current study. There are a lot of research on the effect of sucrose on increase of vase life of cut flowers. Due to its high sugar content, (% 8-10), by supplying required carbohydrates for cut flowers, Cola increase their longevity.

CONCLUSION

Results of this study showed that using simple, safe ingredients available for the environment, such as Cola, as a preservative solution of cut flowers, especially *Alstroemeria* can replace expensive, dangerous and difficult to access compounds.

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