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Investigating the Potential of Increasing the Vase Life of Cut Flower of *Narcissus* by Using Sour Orange Fruit Extract and Sucrose in the Storage Conditions

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Abstract

Narcissus is one of the very popular flowers among Iranians. This flower has a short life. To investigate the increasing of vase life of cut *Narcissus*, sour orange fruit extract in concentrations of 2.5, 4, 5.5 and 7 ml L^{-1} and sucrose in concentrations of 3, 4, 5 and 6% were used. In addition, distilled water was used as a control treatment. In this experiment, characters of vase life and percentage of unopened buds were evaluated in end of experiment, but the relative fresh weight, water absorption, soluble solids of petals and stems were measured from first to 29th day. The longest vase life was obtained in the treatment of sour orange fruit extract with concentration of 4 ml L^{-1} with 30.33 days and the shortest life of control was obtained with 18.33 days. Also, the least and highest percentage of unopened buds were observed in treated flowers with sour orange fruit extract of 4 ml L^{-1} and sucrose of 6%, respectively. The maximum amount of fresh weight, solution absorption, soluble solids of petals and stems were obtained in concentration of 2.5 ml L^{-1} of sour orange fruit extract. In general, results show that sour orange fruit extract and sucrose in low concentrations can be used as healthy, cheap and easy access compounds in vase solution of cut flower of *Narcissus*.

Keywords: Cut flower *Narcissus*, Sour orange fruit extract, Sucrose, Vase life.

INTRODUCTION

Narcissus (*Narcissus tazetta*) is a genus of the Amaryllidaceae family (Dole and Wilkins, 2005) and has a short life. *Narcissus* has an important place among Iranians as a winter cut flower and also has been used as potted plants (Farahmand, 2007).

Delaying the senescence process and increasing the vase life of this cut flower is very important. Various compounds can affect the vase life of flowers that, sucrose can be mentioned among them. Since carbohydrates of cut flowers are limited and are reduced during aging, so the use of external carbohydrates is common to increase their longevity (Monterio *et al.,* 2002). Carbohydrates are the main source of flowers nutrition and the source of energy for biochemical and physiological processes after separation from the mother plant (Keshavarzi and Chamani, 2011). The common carbohydrate used in the vase solution is sucrose. Sucrose provides the required energy for metabolic activity of cells such as maintaining the structure and function of mitochondria and other organelles. In addition, sucrose facilitates transport of water and minerals inside the xylem by controlling transpiration (Capdeville *et al.*, 2003). The results of Keshavarzi and Chamani (2011) showed that 2.5% sucrose caused increasing the vase life of cut flower of *Lilium*. O' Donghue *et al.* (2002) reported that lactase deficiency associated with aging delayed in the flowers, which were fed with sucrose. Fed flowers with sucrose had more strength than the control flowers and the high levels of galactose resisted against entering into the wilting phase.

Van Doorn and Dhort (1994) said that cut flowers wilting have been caused by inadequate absorption of water due to stem end blockage by the growth of bacteria, sediment of materials such as tylose and air embolism. It has been recommended germicidal and fungicidal materials were used in the preservative solution of the cut flowers to prevent the growth of microorganisms (Chanasut *et al.*, 2003).

Several chemical compounds had been investigated to use in the vase solution of cut flowers. However, because some of them are harmful, using natural compounds such as extracts of some fruits, essences and herbal pharmaceutical extracts had been investigated in the last few years. Researches indicate that natural compounds can be appropriate alternatives for chemicals (Solgi *et al.*, 2009).

The results of Mehraj *et al.* (2013) showed that using lemon extract with sucrose caused increasing life of cut snow ball.

Agampodi and Jayawardena (2009) reported that treatment of 50% coconut milk with 0.23% sodium hypochlorite caused increasing solution absorption and vase life of Anthurium until 21^{th}. Babarabie *et al*. (2014) said that apple fruit extract because of some compounds such as malic acid, citric acid and fructose apparently is an appropriate solution for the vase solution of *Alstroemeria.* Results of their research showed that using 45 ml L^{-1} of apple extract caused increasing soluble solids of petals and vase life of cut *Alstroemeria.*

Sour orange (*Citrus aurantium* L.) from Rutaceae family has acidic materials such as citric acid, malic acid and the flavonoid compounds and has high potential for using in different fields (Montazer and Nia Kosari, 2012). Results of Rezvanypour and Osofoori (2011) showed that using 100 mg l^{-1} of citric acid with 10% sucrose caused increasing the vase life and diameter of cut rose flowers. Jamshidi *et al.* (2012) reported that treatment of 200 mg l^{-1} of malic acid caused reduction of the number of bacteria in the vase solution of cut Gerbera and increased the vase life.

The purpose of this research is investigation on effect of sour orange extract as a healthy material, with the suitable and affordable access in the preservative solutions of cut narcissus.

MATERIALS AND METHODS

Narcissus cut flowers were purchased from an amaryllis breeding center in Gorgan and in compliance with the standard conditions were transferred to a chamber located in University of Agricultural Sciences and Natural Resources and they were maintained at 13 ± 2 °C, relative humidity of 65±5% and 450 lux light with 12 hours of light and 12 hours of darkness during testing.

Flowers stem with the height of 30 cm were cut and put inside containers of vase solutions, which had been prepared before the test. Parameters measured included vase life, the percentage of unopened buds, fresh weight, water uptake, soluble solids of petal and stem.

The vase life was considered the time when 50% petals of the flower were wilted (Fig. 5, 6, 7) (Alipur *et al*., 2013). To determine the percentage of unopened buds, the total number of buds on the first day was counted, and then the number of unopened buds were calculated at the end of the vase life. Then, the percentage of unopened buds were calculated by dividing the number of unopened buds on the total number of buds (Mir Saeed Ghazi *et al.,* 2013). The fresh weight of flowers was measured by using a digital scale in days zero, 3, 6, 9, 12, 15, 18 and 21 and were calculated using the following formula.

(RFW) relative percentage of fresh weight = $w_t / w_{t=0} \times 100$

W_t: Stem fresh weight in the same day and days 3, 6, ...

$W_t = 0$: Weight of the stem in day zero

Water absorption was measured in days 1, 5, 9, 13, 17, 21, 25 and 29 and were calculated using the following formula.

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

FW: The amount of absorbed solution

S_t: Solution weight (g) in days zero, 3 and …

S_{t-1}: Solution weight (g) in the previous day

$W_{t=0}$: Stem fresh weight in day zero

For measurement of soluble solids of petals and stem, 0.5 g of them were extracted and °Brix of the obtained extract was measured using a manual refractometer device in days 1, 5, 9, 13, 17, 21, 25 and 29.

Sour orange extract, with 4% sucrose were used in preservative solutions. Treatment of sucrose contained of 3, 4, 5 and 6 percent.

In addition, control contained distilled water. Orange juice soluble solids was 5.8. The study was arranged in a factorial experiment based on completely randomized design with 3 replications that each replication included 5 flowers. Data were analyzed using SPSS software and mean comparisons were done according to the LSD test.

RESULTS AND DISCUSSION

The results of analysis of variance of data showed that the treatment effect on the vase life and percentage of unopened buds were significant at 1% level (Table 1). Also, the effects of treatment, time and interaction between them on relative fresh weight, the absorption of solution, soluble solids of petals and stem were significant at 1% level (Table 2).

Vase life

The results of the means comparison showed that the maximum and minimum vase life were related to concentrations of 4 ml L^{-1} of sour orange extract with 30.33 days and the control (distilled water) with 18.33 days and among the different concentrations of sucrose, concentration of 4% was the best (Table 3). As stated, the citric acid is one of the compounds of sour orange fruit. Citric acid reduces pH and prevents the proliferation and accumulation of bacteria in the cut area and improves the normal flow of water (Ebrahimzadeh and Seifi, 1999). Hassanpour Asil and Hasani (2012) reported that 150 mg L^{-1} of citric acid with 4% of sucrose increased vase life of *Gladiolus* up to 2.7 days. It seems that sour orange extract due to its acidic compounds and sucrose by providing carbohydrates, increased the life of flower. Amaryllis flowers are usually classified

Table 1. Analyses of variance of effect treatment on vase life and unopened buds percentages of cut *Narcissus.*

SOV	df	Vase life	Unopened bud
Treatment	8	44.83**	418.97**
Error	18	0.88	1.23
cv (%)	-	3.94	7.36

** Significant 1%

Table 2. Analyses of variance of treatment and time on measured traits in cut *Narcissus.*

SOV	df	Relative fresh weight	Water uptake	Petal TSS	Stem TSS
Treatment	8	12923.55**	5.84**	2.34**	4.6**
Time	7	26421.22**	9.59**	7.7**	11.94**
Time*treatment	56	2886.51**	1.08**	0.67**	0.99**
Error	144	294.76	0.011	0.06	0.37
cv (%)	-	18.87	22.4	20.9	11.57

** Significant 1%

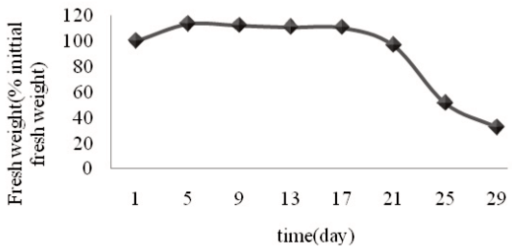

Fig.1. Changing process of relative fresh weight of cut *Narcissus* during the experiment.

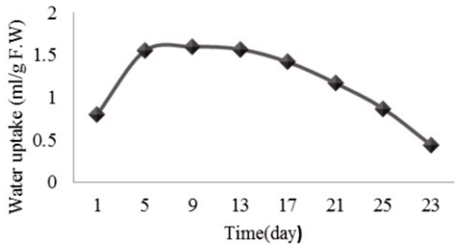

Fig. 2. Changing process of water absorption of cut *Narcissus* during experiment.

as short-life flowers with the lifetime of 4-8 days (Armitage, 2003). Results of Alipour *et al*. (2013) showed that using putrescine increased the vase life of *Narcissus* cut flowers up to 8 days, while the control (distilled water) had vase life of 5 days. In another study, narcissus cut flowers were maintained at both 4 and 16 °C. In addition, they used *Thymus* essence. The results showed flowers treated with the concentration of 100 mg l^{-1} at temperature of 16 ° C had the vase life of 9.25 days and controls 8.75 days, respectively. However, the flowers that were placed at 4° C had the longevity of 58.75 days and their controls had the longevity of 32.25 days (Salehi Sardoie *et al*., 2014). Since narcissus has a short life at room temperature, storing them at low temperature is probably one of the reason of the longer life of control and treated plants.

Percentage of unopened buds

The results showed that the highest and lowest percentage of unopened buds were related to the treatment of 6% sucrose and 4 ml L^{-1} sour orange extract, respectively. Among the concentrations of sour orange, the highest percentage of unopened buds was obtained in the treatment of 7 mg L^{-1} (Table 3). Since the opening flower are required to use ATP and providing the required ATP is needed to break down sugar molecules during the process of respiration, so anything that reduces the amount of plant respiration can delay the opening of flowers and simulating the flower ageing (Mir Saeed Ghazi *et al*., 2013). Preservative solutions at low concentrations of sour orange extract along with sucrose probably cause to reduce or delay the respiration and the aging process of petals.

High concentrations of sour orange extract and sucrose were not suitable treatments, and prevent the floret opening. Talukdar and Barooah (2011) found that 400 mg L^{-1} citric acid with 4% sucrose significantly increased the opening of cut flower buds compared to control.

Table 3. Mean comparison of effect of vase solutions on measured traits after harvesting cut *Narcissus.*

Treatment	Vase life (days)	Unopened bud (%)	RFW (% to initial F.W)	Water uptake	Petal TSS	Stem TSS
O_1	28.33 ^{b}	07.53f ^{g}	126.61 ^{a}	2.00 ^{a}	2.30 ^{a}	1.67 ^{a}
O_2	30.33 ^{a}	06.94 ^{g}	114.95 ^{b}	1.59 ^{b}	2.17 ^{b}	1.68 ^{a}
O_3	26.66 ^{c}	07.82 ^{g}	106.6 ^{bc}	1.47 ^{b}	1.87 ^{c}	1.18 ^{de}
O_4	20.66 ^{f}	29.42 ^{b}	062.17 ^{g}	0.65 ^{d}	1.48 ^{e}	0.79 ^{g}
S_1	22.00 ^{ef}	21.36 ^{c}	072.2 ^{ef}	0.68 ^{d}	1.25 ^{f}	1.04 ^{ef}
S_2	24.00 ^{d}	09.16 ^{ef}	099.77 ^{cd}	1.57 ^{b}	1.73 ^{d}	1.41 ^{b}
S_3	23.00 ^{de}	18.48 ^{d}	094.35 ^{d}	1.09 ^{c}	1.83 ^{cd}	1.35 ^{bc}
S_4	21.66 ^{ef}	32.16 ^{a}	079.38 ^{e}	0.75 ^{d}	1.57 ^{e}	1.25 ^{cd}
C	18.33 ^{g}	10.19 ^{e}	062.45 ^{fg}	0.80 ^{d}	0.90 ^{g}	0.90 ^{fg}

In each column, means with the similar letters are not significantly different at 1% level of probility using LSD test. O1-4: Respectively the concentrations of 2.5, 4, 5.5 and 7 of sour orange extract. S1-4: Respectively the concentrations of 3, 4, 5 and 6 of sucrose. C: control.

The relative fresh weight

The results showed that the highest relative fresh weight related to treatment with 2.5 ml L^{-1} sour orange extract. The lowest relative fresh weight was observed for flowers treated with 7 ml L^{-1} sour orange extract. In addition, among the concentration of sucrose, 4% sucrose had the highest relative fresh weight (Table 3). The relative fresh weight changes showed that it was increasing until the fifth day and decreased until 29th day (Fig. 1).

By passing the storage time, fresh weight and solution absorption reduce. The fresh weight loss of flower by increasing the number of days after harvesting is due to loss of water by the flower organs (Mir Dehghan *et al*., 2012). The nearly same results have been obtained from increasing the relative fresh weight of cut flowers. Basiri *et al*. (2011) stated that lemon extract and sucrose significantly increased relative fresh weight of carnation cut flowers compared to control. It seems that maintaining the relative fresh weight of flower by sour orange extract is because of preventing vascular occlusion by this compound. Sucrose accelerates water relations by providing an osmotic molecular activity, and nearly causes to maintain relative fresh weight of the flower.

Water absorption

The results of the means comparison showed that the highest water absorption related to treatment with 2.5 ml L^{-1} sour orange extract and the lowest one related to treatment with 7 ml l^{-1} sour orange extract. Among the concentration of sucrose, 4% sucrose had the maximum water absorption (Table 3). The water absorption changes showed that it was increasing until 13th day and after that, it started to decrease (Fig. 2).

Citric acid that is used in the vase solution by reducing the pH of the solution and controlling microbial activity enhances the solution absorption and increases the durability of the flowers (Abedini *et al*., 2007). Sour orange extract, which contains citric acid, probably enhances water absorption in narcissus cut flower by this action. Abshahi *et al*. (2014) reported that the treatment

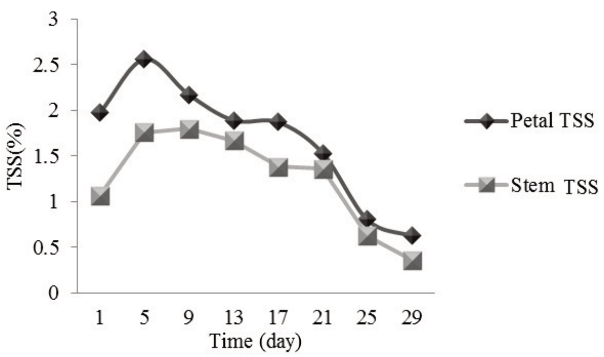

Fig. 3. Changing process of total soluble solid of petal and stem of cut *Narcissus* during experiment.

Fig. 4 . Stem browning of cut flowers of *Narcissus* treated by 7 ml L^{-1} of sour orange extract on 20th day of experiment.

Fig. 5. Flower treated by 4% sucrose (20th day).

Fig. 6. Control treatment (20th day experiment).

Fig. 7. Flower treatment by 4 ml L^{-1} sour orange extract (20th day experiment).

of lemon and coconut milk extract enhances the absorption of solution by cut leaves of *Cycas*. Also, it seems that sucrose used in the vase solution has increased osmotic pressure in plant tissue, thereby, has increased the plant's ability to absorb more water.

The soluble solids of petal and stem

The results showed that the maximum amount of soluble solids of petal was obtained in treatment with 2.5 ml L^{-1} sour orange extract and the minimum amount was obtained in control. The maximum amount of soluble solids of stem was observed in 2.5 and 4 ml L^{-1} sour orange extract and the minimum amount was observed in 7 ml L^{-1} sour orange extract. The concentration of 4% of sucrose had the maximum amount of soluble solids of stem. In addition, changing the amount of soluble solids of petal and stem showed that it was increasing until 5th day and after that, it started to decrease (Fig. 3).

Soluble solid content of petals was more than stems during the experiment. This has probably happened due to the decomposition of starch of petals and carbohydrates stored in stem and their transferring from stem to petals (Mir Saeed Ghazi *et al*., 2013). There are soluble carbohydrates in petals that reduce the water potential and as a result cause an increase in the absorption of solution (Ho and Nichols, 1997). In a research on chrysanthemum cut flowers, the use of lemon extract and sucrose enhances the absorption of soluble solids of petals and solution (Basiri *et al.,* 2011).

CONCLUSIONS

The results of current study showed that low concentrations of sour orange extract with pH 5 to 6 can increase the vase life and some qualitative characters of narcissus cut flowers after harvesting. Although, other concentrations were also increased the vase life, but they caused negative effects such as not opening florets and excessive browning of stems (Fig. 4). In addition, it was found that the concentration of 4% sucrose was the best concentration for increasing the vase life. Although sucrose alone increased the life, but the flowers treated with sour orange extract and sucrose solution had the longer life. This is probably due to resolving vascular obstruction by acidic compounds of sour orange extract and providing appropriate conditions for sucrose uptake by the flowers.

Overall results showed that, orange sour extract as a healthy material with an appropriate and easy access along with sucrose can be used to maintain cut flowers of *Narcissus* in a storage condition and homes.

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