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Effect of butanol, propanol and pentanol on the quality of cut Carnation cv. 'Nelson'

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Abstract. Carnation (*Dianthus caryophyllus* L.) is one of the most popular cut flowers in the world with the most economical importance to flower industry. This plant is categorized among cut flowers and is very sensitive to ethylene. A symptom of senescence in carnation is curving of its petals inward. In this sense, with regards to the role of Alcoholic compounds in preventing bio-synthesis of ethylene as a senescence preventing agent and increasing the preservation of cut flowers postharvest, the effect of different treatments including propanol, butanol, and pentanol on carnation 'Nelson' was investigated at 4 levels (0%, 2%, 4%, and 6%) taken randomly. Variables such as vase life, fresh weight, chlorophyll *a*, petal protein, and ethylene were measured. Findings showed that treatments with 2% and 4% of propanol caused the longest vase life and the least decrease in fresh weight while, in comparison with distilled water, pentanol especially at 4% and 6% had a significantly negative effect on the amount of protein. Except for curing with pentanol, the amount of ethylene increased notably particularly in high densities and propanol at 4% showed the largest amount of chlorophyll *a*.

Key words: propanol, butanol, pentanol, vase life, *Dianthus*.

Introduction

Carnation (*Dianthus caryophyllus* L.) from the family Caryophyllaceae, has been cultivated for more than 2000 years and includes annual, biennial and perennial plant species (Matlubi 2004). In many countries, carnation is one of the most popular cut flowers and of great economic importance in flower planting trade. It has the second place in flower production after rose. Because of considerable amount of absorbed water its quality is preserved after long transportation, and this makes it a favorite flower for producers and consumers (Satoh et al. 2005). Postharvest senescence is one of the restrictions of the supply of most the cut flowers. In this way, whatever factor that postpones its senescence process can be helpful in improving its vase life. Most metabolic processes that contribute to senescence are associated with Ethylene (Haakana et al. 2001). Considering exportation importance of carnation, therefore, increasing its production, preservation, and vase life has always been the focus of researchers.

Satoh et al. (2005) presented a method for determining the vase life of cut spray carnation flowers. Studies of essential oils, ethanol and methanol (Karimian Fariman & Tehranifar 2011) and boric acid (Ahmadnia et al. 2013) effects on cut carnation have been done. Edrisi et al. (2012) studied the effects of chemicals on vase life of cut carnation and microorganisms population in the vase solution.

Effect of some chemical components have been studied on cut flowers such as commercial antiethylene products for fresh cut flowers (Stabyl et al. 1993); ethanol and ethylene on cut *Lisianthus* (Farokhzad et al. 2005); methanol, ethanol on cut *Chrysanthemum* (Petridou et al. 2001); ethanol, methanol and essential oils on *Alstroemeria* (Mousavi Bazaz & Tehranifar 2011); some preservative solutions on *Antirrhinum majus* L. (Asrar 2012); ethanol on Rose (Hamidi Imani et al. 2013) and antibiotics and essential oils on *Chrysanthemum* (Hashemabadi et al. 2013). With regard to the role of alcoholic compounds in preventing bio-synthesis of ethylene as a senescence preventing agent, their performance affects growth and development of plant organs (Jafari Marandi and Majd 2008). Research shows that ethanol has had an acceptable influence on postharvest flower vase life of carnation (Wu et al. 1992). Therefore, it is believed that other types of alcoholic compounds might be helpful in increasing carnation vase life.

In the present study, due to the great importance of flower postharvest vase life and of the effect of alcoholic treatments on vase life and improvement of the quality of plant products as a result of alcoholic treatments an attempt has been made to assess the effect of propanol, butanol, and pentanol, on vase life and flower quality of cut carnations.

Materials and methods

Cut carnation were harvested at commercial stage from a greenhouse in Mahallat and were transferred to the postharvest laboratory of Islamic Azad University of Rasht Branch, Iran in the experiment was arranged according to a completely randomized design. It included treatments with propanol, butanol, or pentanol, each at four levels (0%, 2%, 4%, and 6%) with three replications of five flowers each.

The growth room conditions were 12:12 (L:D) hours, 20±2 °C, 60 to 70% RH and 12 ìmol s^{-1} m^{-2} light intensity and the following parameters were measured.

Vase life was measured as days until flower wilting (Ferrant et al. 2002).

Fresh weight

Considering the amount of initial fresh weight, final fresh weight, recut weight, and pruning weight of flower the amount of decrease in fresh weight was estimated according to Hashemabadi (2006).

Fresh weight= Initial fresh weight – (Final fresh weight + Recut weight + Pruning weight).

Protein content of petals

One flower was taken out of each plot on the fifth day of vase life, for protein quantitative determination according to Bradford (1976).

During the 5th day, the petals were dried in the oven. The small pieces of each sample were poured in the volumetric flask. The samples were digested using 3gr of salicylic acid, 50 cc sulfuric acid, and 20 cc distilled water. Hydrogen peroxide and hotplate were used for

distillation stage. The process was continued until all samples color changed to yellow. Titration was completed using sulfuric acid. Finally, nitrogen content was calculated using following formula and then, protein content of petals was calculated:

Nitrogen (N)= 0.05× 0.56× acid sulfuric used for every plant sample × $\frac{50}{0.3}$

Petal's protein= N×6.25

Chlorophyll *a*

On the fifth day of the experiment, one flower was taken randomly out of each plot for chlorophyll determination. Petals were dried and amounts of chlorophyll *a* and total were measured.

Based on Mazumdar & Majumder (2003), 0.5gr of each sample was grinded in 30cc mixed of 80% acetone and 20% distilled water. The mixture was passed through filter paper and 20cc distilled water was added to obtained solution.

Spectrophotometry plant was used to measure leaf chlorophyll and two wavelengths of 660nm and 643nm were read for chlorophyll *a*:

Chlorophyll *a* (mg g^{-1}FW) = 9.93 (A_{660}) – 0.777 (A_{643})

(A_{660}): The number was read for the plant sample by spectrophotometry plant at the wavelength of 660

(A_{643}): The number was read for the plant sample by spectrophotometry plant at the wavelength of 643

Ethylene

Measurement of ethylene was conducted on one flower of each plot in the second (Chamani 2005). The 25cm branches were cut off and in a septum-equipped jar were poured with 100cc of preservative solution consisting of distilled water, sucrose and 8-HQS. Produced CO_2 were absorbed by a cup containing 40cc of KOH (1 molar) that was put in the jar. To increase contact level of KOH and CO_2, a filter paper was placed in the KOH-containing cup. Ethylene content was determined using a Shimidzu gas chromatograph equipped with an activated aluminum column fitted with a flame ionization detector. Gas analysis was made in the laboratory of College of Agriculture & Natural Resources, University of Tehran.

Ethylene production (nl l^{-1} h^{-1} g^{-1} SW) was measured 24 h after treatment. Three flowers were sealed in a glass jar and all jars were kept at 20°C. After 24 h, 10 ml gas samples were withdrawn for ethylene determination.

The qualitative results (stated in ml l^{-1}) were placed in the following formula:

$$EP\left(nl\ \ l^{-1}.H^{-1}.g^{-1}.FW\right)=\frac{E\times V\times 60}{T\times W}$$

EP: Produced ethylene

E: Concentration of ethylene found inside of Venoject tube (nl.l^{-1})

V: Glass volume after deduction of weight of flower, KOH, 8-HQS (L)

T: Duration that flower branches were put in jar (hr)

W: Wet weight of the samples (gr)

FW: Wet weight of flower branches

Data were analyzed using SPSS statistical software and mean comparisons was performed by Duncan's test.

Results and discussion

Vase Life

Used treatments showed significant differences (P<0.05). The longest vase life were observed in P2 (propanol 4%) with 13.73 days, while it was 9 days in control (Fig. 1). This might be due to the fact this alcohol is poisonous especially in high concentration. In control, vase life was about 9 days (Fig. 1). These findings are in agreement with those of Wu et al. (1992) in which alcoholic treatments with longer chains gradually decreased postharvest vase life of flowers.

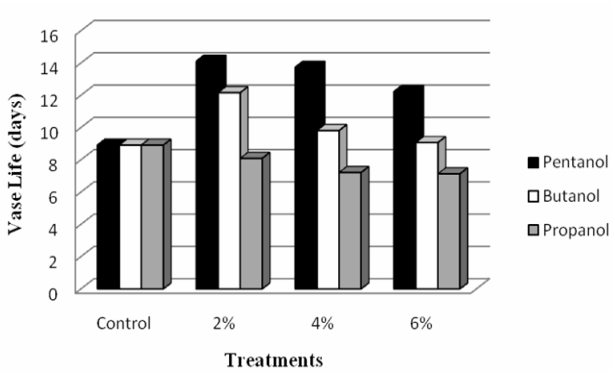

Figure 1. Carnation vase life at 0%, 2%, 4%, and 6% levels of different alcoholic treatments.

It is believed that propanol and butanol impede synthesis and performance of ethylene in low concentrations and that is why they increase carnation vase life. Such anti-ethylene substances delay petal senescence which turn petals into brown and prevent ovary's growth or its death. These findings confirmed results of Jones (1987) and Sharif (2007).

Fresh weight

Diverse treatments caused a significant decrease in fresh weight (P<0.05). The minimum decrease in fresh weight occurred in alcoholic treatments with low concentrations especially P1 and P2 (propanol 2% and 4%) and the maximum in alcoholic treatments with high concentrations particularly T2 and T3 (pentanol 4% and 6%) (Table 1). Generally, propanol and butanol delay decrease of flowers fresh weight in low concentrations. Shimizu and Ichimura (2005) believe that cut flowers fresh weight increases after being put in water but decreases subsequently. Decrease of fresh weight can happen as a result of reduced water absorption, lose of water, or increase in respiration (Ezhilmathi *et al.* 2007). Researches show that alcoholic compounds prevent vessel blocking in low concentrations and increase cell water, therefore postpone the process of flower senescence, and keep fresh weight at high levels (Heins 1980). Some micro-organisms such as bacteria, blocking xylem vessels are one of the main reasons of fresh weight decrease because they prevent water moving up (Witte & Van Dorm 1991, Anonymous 2000, Liao *et al.* 2001). It seems that the use of alcoholic compounds in low concentrations as anti-bacterial agents- prevents vessel blockin and leads to decrease in evaporation, transpiration and respiration and consequently leads to an increase in carnation fresh weight. Findings of Shimizu and Ichimura (2010) for cut *Lisiantus* and Sood et al. (2006) for cut roses confirm these results.

Chlorophyll *a*

According to the table of analysis of variance, the effects of treatments with alcohols on chlorophyll *a* were significant (P<0.05). Means comparison showed that increasing concentration of butanol and pentanol leads to a decrease in chlorophyll *a*, while increasing propanol concentration first leads to an to a increase and then decrease in chlorophyll *a*.

Table 1. Mean comparison of different concentrations of propanol, butanol and pentanol on the measured traits on Carnation.

Treatment	Level	Petals protein (%)	Decrease of fresh Weight (g)	Total chlorophyll (mg g^{-1} FW)	Ethylene (nl $l^{-1}h^{-1}g^{-1}$FW)
Control	0	11.26 a	12.93 b	4.61 c	1.58 c
Propanol (P)	(P1 2%)	11.34 a	9.09 d	8.47 a	1.34 d
	(P2 4%)	11.97 a	8.91 d	8.97 a	1.25 a
	(P3 6%)	8.47 b	10.01 c	6.76 b	1.19 f
Butanol (B)	(B1 2%)	8.24 b	9.98c	6.69 b	1.18 f
	(B2 4%)	8.13 b	12.91 b	4.87 c	1.15 g
	(B3 6%)	7.94 b	13.26 b	4.79 c	1.16 g
Pentanol (T)	(T1 2%)	5.91 c	13.49 b	5.11 b	1.61 b
	(T2 4%)	4.18 d	15.72 a	3.34 d	1.78 a
	(T3 6%)	4.72 d	16.17 a	3.46 d	1.73 a

*Similar letters in each column indicate not significant difference at 1% and 5% (Duncan's test).

Among different concentrations, P2 (propanol 4%) was the best treatment with 8.97 mg g^{-1} FW, while T2 (pentanol 4%) with 3.34 mg g^{-1} FW had the lowest amount of chlorophyll *a*. It seems that this anti-ethylene treatment prevents degradation and preserve chlorophyll in petals. According to Sadeghinasab (2011) ethanol and methanol at 2% cause the least amount of degradation of chlorophyll *a* and *b*. Such as methanol, ethanol increased flower vase life and petal chlorophyll (Heins 1980). Hashemabadi et al. (2009) concluded that anti-bacteria and ethylene combinations increase chlorophyll content of petals.

Protein content of petals

The effect of alcoholic treatments on protein content of petals was significant (P<0.01). The results showed long-chain alcoholic compounds in high concentrations cause protein degradation. P1 treatment (propanol 2%) was observed to be the best treatment with 43.16%, while the highest amount of protein degradation was seen in high alcoholic concentration treatments (i.e. of 4% and 6%) (Table 1). Senescence of cut flowers involves hormonal mechanisms of physical and biochemical changes in cell membranes (Borochov & Woodson 1989). Sadeghinasab (2011) observed significant increase in protein of carnation when treated by alcoholic compounds. The application of anti-ethylene compounds on cut rose 'Yellow Island' increases protein of petal by increasing the strength of cell membrane (Gerailoo & Ghasemnezhad 2011). An increase in the amount of protein may be the result of synthesis of new protein and/or a protein degradation slowdown. Protein loss has been studied in some plants such as *Alestroemeria* and carnation and it has been shown that senescence generally decreases protein (Jones & Hill 1992).

Podd and Van Staden (2002) investigated the effect of ethanol on conservation of cut flower *Dianthus* and found out different levels of ethanol cause a decrease in protein content of petals while treated flowers with distilled water had the highest amount of protein.

Ethylene production

Significant statistical difference (P<0.01), existed among different treatments in ethylene production, which is considered to be a critical agent in flower preservation. According to means comparison, the strongest inhibition of biosynthesis of ethylene production was observed in propanol and butanol 2% and the highest amount of ethylene production was observed in pentanol 4% and 6%. There was no significant difference between control and T1 (pentanol 2%) (Table 1). It seems that increasing flower preservation by low concentration of alcoholic treatments (vase life being 1.5 times longer than control) is directly related to the effect of such treatments on controlling bio-synthesis of ethylene (Wu et al. 1992).

One of the main reasons of postharvest ethylene decrease is the presence of ethylene in the surrounding environment. Therefore, an important strategy to increase vase life of cut flowers is to prevent the production and activity of ethylene (Gast Karen 1997). It is possible that low concentrations of propanol and butanol prevent synthesis of ethylene by decreasing ACC synthesis and ACC oxidation and consequently cause an increase in carnation vase life.

Jafari Marandi and Majd (2008) believe that the effect of alcoholic treatments (ethanol and methanol) on cut carnations decrease the production of ethylene and such treatments cause a delay in senescence and withering of cut flowers. Findings of this study is in accordance with those of the present, i.e. controlling production of ethylene by ethylene synthesis inhibitors.

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