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European Journal of Experimental Biology, 2012, 2 (6):2485-2488

ISSN: 2248 –9215
CODEN (USA): EJEBAU

Effect of Sodium Benzoate on Longevity and Ethylene Production in Cut Rose (*Rosa hybrida* L. cv. Avalanche) Flower

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ABSTRACT

Effect of sodium benzoate (0, 150, 200 and 250 mg l^{-1}) on longevity and ethylene production of cut rose (Rosa hybrida L. cv. Avalanche) flowers was studied. Data were recorded for vase life, loss of fresh weight, ethylene production, SPAD value, Brix index, bacterial population in vase solution, flower opening index and protein content. A result revealed that 250 mg l^{-1} of sodium benzoate was the most effective on vase life of rose cut flowers and increased it. Also, sodium benzoate reduced ethylene production. Sodium benzoate had significant effect on other traits measured in present study.

Keywords: Rose cut flower, Sodium benzoate, Vase life, Ethylene production.

INTRODUCTION

Rose (*Rosa hybrida* L.) belongs to the Rosaceae family which identified as the highest demand in the world [12]. Rose is used for decorative purposes and is prized for its delicate nature, beauty, charm and aroma [3, 5]. Vase life of cut rose reduces by ethylene production, bacterial contamination in vase solution, wilting and bent neck [14]. Finding a new approach for extending the vase life of cut rose flower is necessary. Nowadays, application of biocide and ethylene inhibitor preservative compounds such as hydroxyl quinoline derives, cobalt chloride, aluminum sulphate, sodium benzoate and silver nano-particles is commonly for delayed senescence and extending the vase life of cut flowers [4, 5, 9, 17]. Sodium benzoate as an antifungal compound reduces microorganisms' activity and bacterial contamination in vase solution [17, 19]. Ketsa and Sribunma [11] showed that pulsing treatment with sodium benzoate at 300 mg l^{-1} concentration for 24 h gave maximum vase life in cut rose cv. 'Christian Dior' flower. Oraee et al. [17] studied the effect of malic hydrozide and sodium benzoate on vase life of cut gerbera (*Gerbera jamesonii*) and found that all of the treatments had positive effect on flower longevity. The purpose of this study was to evaluate the effect of different concentrations of sodium benzoate on the vase life, loss of fresh weight, ethylene production, SPAD value, Brix index, bacterial population in vase solution, flower opening index and protein content of rose (*Rosa hybrida* L. cv. Avalanche) cut flowers.

MATERIALS AND METHODS

Cut roses (*Rosa hybrida* L. cv. Avalanche) were grown in a standard greenhouse conditions in Amol city, Iran. Flowers were harvested at half open stage and were brought to the laboratory of Islamic Azad University, Rasht Branch, immediately. Prior to imposition of treatments, the stems were uniformly re-cut under distilled water. Re-

cut stems were ~60 cm long. Cut flowers were pulse treated for 24 h with certain concentrations of sodium benzoate and the cut flowers were then kept in 500 ml sucrose 3% and 300 mg l^{-1} 8-hydroxyquinoline stock vase solution.

The experimental design was a randomized completely blocks design (RCBD) containing four sodium benzoate concentrations (0, 150, 200 and 250 mg l^{-1}) × three replications in 12 plots. In each plot, five cut rose flowers were placed into 1000 ml vase filled with 250 ml of preservative solutions including the aforementioned matters. Then, these cut rose stems were placed into 1000 ml vases filled with 500 ml of preservative solutions supplemented with 3% sucrose and 500 mg l^{-1} 8-hydroxyquinoline sulphate. Distilled water was used as a control. The mouths of the vases were covered with a sheet of paper to minimize evaporation and to prevent contamination. The flowers were kept in a vase life room under the following conditions: 20±2°C, relative humidity of 70-75%, 15-20 µmol m^{-2} s^{-1} light intensity (cool white florescent tubes) and a daily light period of 12 h.

Vase life of the cut stems was assessed daily; throughout the vase life evaluation. The end of vase life is defined taking into consideration the visible wilting and stem bending more than 90°. The 2 cm samples of stem butt were taken to determination of total soluble solid (TSS) contents of rose's stems. TSS content was measured by using hand refractometer. The hand refractometer with the range of 0 to 30 °Brix was used to determine TSS by placing 1 to 2 drops of rose stem juices on the prism. Chlorophyll content in leaves was measured by chlorophyll meter SPAD-502, Minolta Co. Japan which represented by SPAD value. The leaf was inserted into the meter and measured SPAD value two times from different middle spot of two decussate leaves in second or third nodes.

Fresh weight was measured with a digital balance. The first measurement was calculated exactly after the pulse treatment and the last one was calculated at the last day of vase life. Loss of fresh weight was obtained by following formula: fresh weight in first day of experiment – fresh weight at the end of vase life. Flower opening index was measured with a digital caliper as the following expressions: (the biggest diameter of the flower + the perpendicular diameter to it ÷ 2) every other day. The first measurement was done exactly after the pulse treatment and the last one was done at the day which flower diameter was maximum size. To determine the dry matter, cut flowers were exposed at 70°C for 24 h in an oven. To determine vase solution bacterial populations, aliquots were taken from vase solutions. Dilution was carried out with 0.9% sterile normal saline to achieve 30-300 bacterial colonies in any one Petri dish. The 0.1 ml of aliquots was spread on nutrient agar plate. Then, they were incubated at 37°C for 24 h before counting of bacteria. Colony counts were expressed as colony forming units per ml (CFU m l^{-1}). To determine protein content measured mass of dry petals (0.3 g) were soaked in acids mixture (sulfuric acid and salicylic acid). Clear liquid was achieved after several times heating and adding H_2O_2. Measuring of total nitrogen was done by titration after distillation method. The outcome number was multiplied by protein factor. Ethylene content was determined by gas chromatography, using a Shimidzu gas chromatograph. Ethylene production was measured 24 h after pulse 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. Ethylene content was determined using a Shimidzu gas chromatograph equipped with an activated aluminum column fitted with a flame ionization detector.
Data were subjected to analysis of variance (ANOVA) in MSTATC statistical software and means were compared by the least significant difference (LSD) test at the 0.05 and 0.01 of probability level.

RESULTS AND DISCUSSION

Vase Life

Statistical analysis showed that the effect of sodium benzoate was significant at 5% (Table 1). Longest vase life was found in 250 mg l^{-1} sodium benzoate (Table 2). Positive effect of sodium benzoate on vase life of cut rose led to anti-ethylene activity, so it can be the senescence inhibitor agent [13]. Our results showed that in high concentration of sodium benzoate, vase life was increased. Sodium benzoate has antimicrobial properties and this can be the cause of vase life extension in cut rose flowers [15]. Sodium benzoate increased vase life of cut gerbera (*Gerbera jamesonii*) flowers [17]. In a study on cut rose flowers, sodium benzoate (1000 and 1500 mg l^{-1}) increased vase life compared to the control [19]. Biao et al. [2] found that the use of sodium benzoate improved vase life and postharvest quality of cut rose.

Brix Index

Sodium benzoate had significant effect on Brix index in 5% level (Table 1). The 150 mg l^{-1} sodium benzoate was the best in this case (Table 2). Improving brix index is because of the continuous re-cutting under water and osmotic potential [8]. Our results are in agreement with findings on cut Chinese roses. Mohammadi et al. [16] reported that anti-ethylene compounds improved total solid solution in *Gladiolus grandiflora*.

SPAD Value

Analysis of variance showed that the effect of sodium benzoate on chlorophyll content was significant in 1% level (Table 1). Based on mean comparison, 250 mg l^{-1} sodium benzoate inhibited loss of chlorophyll more than that of control (3.982 and 10.768, respectively (Table 2). Gaballah and Gonma [6] found that sodium benzoate increased leaf area in *Vicia faba* L. Hashemabadi [8] showed that the chlorophyll content in cut carnation flowers, treated by antimicrobial compounds was considerable improved. A positive effect of antimicrobial compounds on cut carnation cv. 'White liberty' was reported by Basiri Zarei [1].

Bacterial Population in Vase Solution

Analysis of variance of the effect of sodium benzoate on bacterial population in vase solution was significant at 1% level (Table 1). Our results exhibited that the 150 mg l^{-1} sodium benzoate decreased bacterial colonies compared to the control (Table 1). Positive effect of sodium benzoate on bacterial contamination is due to the antimicrobial properties of sodium benzoate on microorganisms' contamination [17]. Our results were confirmed by some other researchers [2, 17, 19]. Solgi et al. [18] showed that natural antimicrobial compounds reduced bacterial colonies and extended the vase life of cut gerbera cv. Dune flowers.

Fresh Weight Loss

Analysis of variance of this trait exhibited that sodium benzoate significantly effects at 5% probability level (Table 1). Mean comparison of data in levels of sodium benzoate showed that 250 mg l^{-1} with 3.838 g induced lowest loss of fresh weigh in all of the treatment and 150 mg l^{-1} with 3.934 g reduced 4 g loss of fresh weight compared to the control (Table 2). Improving fresh weight by sodium benzoate is due to the ability of this compound to delay water content loss [2]. Yuhua et al. [20] studied on *Lilium longiflorum* and found that the application of sodium benzoate increased fresh-like quality. Oraee et al. [17] revealed that sodium benzoate at 250 mg l^{-1} increased fresh weight quality of cut gerbera flowers. Jian et al. [10] showed that the suitable concentration of sodium benzoate increased fresh weight in *Paeonia lactiflora* cut flowers.

Flower Opening Index

Data analysis showed that the effect of different concentrations of sodium benzoate was significant on the flower opening index ($p \leq 0.05$) (Table 1). Sodium benzoate was effective on this character (Table 2). Biao et al. [2] demonstrated that sodium benzoate could delay the decline time of fresh weight and flower diameter in cut rose flowers. Younis et al. [19] showed that sodium benzoate by delay on flower opening period increased vase life of cut rose. Biao et al. [2] believed that sodium benzoate at 1500 mg l^{-1} improved flower diameter in cut roses.

Protein Content

Effect of sodium benzoate on protein content was significant in 1% level (Table 1). The 250 mg l^{-1} sodium benzoate induced the greatest amount of protein (Table 2). Yuhua et al. [21] reported that 16 mg l^{-1} sodium benzoate increased membrane stability in petals of chrysanthemum, gerbera and rose. The 16 mg l^{-1} sodium benzoate had positive effect on stability of cell membrane in cut lily flower [20]. The use of anti-ethylene compounds on cut rose cv. 'Yellow Island' caused high protein content [7]. Our results are in agreement with these findings.

Ethylene Production

Data analysis showed that the effect of sodium benzoate was significant on ethylene production ($p \leq 0.01$) (Table 1). Mean comparison of the data showed that among the different concentrations of sodium benzoate, 250 mg l^{-1} of it indicated the minimum ethylene production (0.578 nl l^{-1} g^{-1} FW) as compared to the control (Table 2). Ketsa and Seribonma [11] revealed that a pulse treatment of cut rose flowers with sodium benzoate reduced ethylene production.

Table 1: Analysis of variance of the effect of the sodium benzoate on some traits of cut rose cv. Avalanche.

Source of variations	df	Vase life	°Brix	SPAD value	Bacterial population in vase solution	Loss of fresh weight	Flower diameter	Protein content	Ethylene production
Sodium benzoate	3	6.687*	1.043*	103.127**	1636.805**	27.739*	0.1486*	306.506**	0.051**
Error	32	2.593	0.446	21.552	288.020	7.859	0.028	0.040	0.010
Total	47	-	-	-	-	-	-	-	-
CV (%)	-	14.449	15.490	66.560	38.244	57.710	5.022	8.859	16.016

**: significant at 1%, *: significant at 5%, ns: no significant

Table 2: Mean comparison of the effects of sodium benzoate on some traits of cut rose cv. Avalanche.

Sodium benzoate (mg l^{-1})	Vase life (day)	˚Brix	SPAD value	Bacterial population (log^{10} CFU ml^{-1})	Loss of fresh weight (g)	Flower diameter	Protein content (%)	Ethylene production (nl l^{-1} g^{-1} FW)
0	10.08b	3.88b	10.76a	60.00a	7.08a	3.22c	15.74d	0.72a
150	11.33ab	4.54a	7.60ab	32.50b	3.93b	3.48a	23.81b	0.61b
200	11.33ab	4.34ab	5.54b	45.41b	4.57b	3.38ab	22.82c	0.58b
250	11.83a	4.47a	3.98b	39.58b	3.83b	3.32bc	27.90a	0.57b

Means followed by the same letters in each column are not significantly different by LSD test at 1% level

CONCLUSION

In conclusion, our results showed that sodium benzoate has antimicrobial and anti-ethylene properties and delayed senescence in cut rose cv. Avalanche. Utilization of sodium benzoate decreased bacterial contamination in vase solution. We suggested that this compound can be applied on the other cut flowers.

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