

A method for determining the vase life of cut spray carnation flowers

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Abstract

Cut flowers of carnation are classified into two types, the standard type with one flower on a stem and the spray type with multiple flowers on a stem. The vase life of carnation flowers has been generally determined by observing senescence profiles, *i.e.*, in-rolling of petal margin and wilting of whole petals as well as ethylene production. In the present study, we tried to determine the vase life of spray type carnation flowers by observing the number of open flowers, *i.e.*, the percentage of open flowers to the total number of initial flower buds. The vase life determined by this method was similar to that determined by the former method, and was useful to evaluate the action of preservatives on carnation flowers.

Key words: Carnation flowers, ethylene production, preservatives, spray type, vase life, sucrose, DPSS (1,1-dimethyl-4-(phenylsulfonyl)semicarbazide).

Introduction

In many countries, carnation is one of the most popular cut flowers and of highest economic importance in the floriculture industry. Cut flowers of carnation are used in two forms or categories, *i.e.*, the standard type in which carnations have one flower on a stem and the spray type in which carnations have multiple flowers on a stem. In recent years, spray type carnation flowers have become popular because they can be grown with less labour and meet modern consumer's demand. Carnation cultivars differ in the length of the vase life of cut flowers (Nukui *et al.*, 2004), which is one of the characteristics determining the commercial value of the ornamental flowers. Thus, it is of economical importance to know the vase life of cut carnation flowers of different cultivars.

Ethylene is a primary plant hormone involved in the senescence of cut carnation flowers (Borochoy and Woodson, 1989; Reid and Wu, 1992). A large amount of ethylene is produced, mostly in the petals, several days after full opening of the flower (Woodson *et al.*, 1992). The increased ethylene production promotes the in-rolling of petals resulting in wilting of the flower. The time of onset of ethylene production and the amount of ethylene produced in the flowers vary with the carnation cultivar, and thus influence their vase life (Nukui *et al.*, 2004).

Usually the vase life of carnation flower has been determined by observing senescence profiles, *i.e.*, in-rolling of petal margin and wilting of whole petals as well as ethylene production. This method has been used successfully for cut carnation flowers of the standard type. However, in spray type carnation flowers, the vase life of the flowers is determined by the sum of the flowering period of each flower. Therefore, a method of determining the vase life of the cut flowers of the spray type needs to be established. In the present study we tried to determine the vase life of cut carnation flowers of the spray type from the percentage

of open flowers to the total number of initial flower buds and evaluated the efficacy of this method.

Materials and methods

Plant materials: Flowers of a carnation cultivar *Dianthus caryophyllus* L. 'Light Pink Barbara' (LPB) that belong to the spray type were used. Flowers at the usual commercial stage of flowering, at which the first flower out of six to eight flower buds on a stem was almost fully open, were harvested in the morning at nurseries of commercial growers in Miyagi Prefecture. The harvested flowers were transported dry (without dipping the cut stem end in water) to the laboratory on the day of harvest. Stems were trimmed to 40 cm, and put into bottles with their cut end in distilled water. They were left for one or two days under a 14-h day ($15 \mu\text{mol m}^{-2}\text{s}^{-1}$ with white fluorescent light) and 10-h night regime at 23 °C.

In the experiments with single flowers (Fig. 1), the second or third flower on the stem was detached from the stem when they became fully open and used. The fully open stage of flowers was the stage at which their outermost petals had just reached right angles to the stems. This time point was designated as day 0. In the experiment with spray-type carnation plants with multiple flowers on a stem (Fig. 2), the cut flowers were used immediately after they were delivered. Each multiple cut flower stem was prepared to have five or six flowers and buds in total by removing the immature tight buds.

Determination of the vase life of carnation flowers: For the determination of the vase life by the observation of senescence profiles and ethylene production (Fig. 1), cut flowers with single flowers at their fully open stage (day 0) and 3 cm in stem length were placed in 50-ml glass vials with their stem end in 20 ml distilled water (one flower per vial). Five flowers were used per experiment. The distilled water was replaced every three days

during incubation. The flowers were left under the light condition described above. Ethylene production in each flower was examined once a day as described later, and each flower was observed daily to record senescence symptoms, *i.e.*, in-rolling and subsequent wilting of petals, desiccation and discolouration of the petal margins.

For the determination of vase-life of cut carnation flowers with multiple flowers on a stem (Fig. 2), stems of cut flowers were trimmed to 40 cm and bunches of four stems, each having five or six flower buds (23 buds in total per bunch), were put in 1-liter glass jars with their stem end in 250 ml of the test solution (one bunch per glass jar). The cut flowers were left under the conditions described above for 7 days, during this period the test solutions were renewed once in the middle of the incubation period. The test solutions were distilled water (control), 0.1 M sucrose and 0.2 mM 1,1-dimethyl-4-(phenylsulfonyl)semicarbazide (DPSS) solutions. 8-Hydroxyquinoline sulfate at 200 mg l⁻¹ was added to each solution as a germicide. After the above pretreatment, the cut flowers were put in distilled water and observed daily to record senescence symptoms described above. Fully-open non-wilted flowers were counted daily and the percentage of these flowers to the total number of initial flower buds (23) per bunch was calculated. The vase life of the cut flowers in days is expressed by the number of days during which the percentage of fully-open non-wilted flowers was 40 % or more. Experiments were repeated three times with similar results, and the results of one typical experiment are shown here.

Measurement of ethylene production: Ethylene production in carnation flowers was measured by enclosing five flowers in 350 ml glass containers (one flower per container) for 1 h at 23 °C. A 1 ml gas sample was taken into a hypodermic syringe from the container through a rubber septum on the lid of the container, and analyzed for ethylene with a gas chromatograph (263-30, Hitachi, Tokyo) equipped with an alumina column and a flame ionization detector. Ethylene production in nmol (g fresh weight)⁻¹ h⁻¹ was expressed as the mean ± SE of the five flowers.

Results and discussion

Determination of the vase life by observing senescence profiles and ethylene production: First we examined the vase life of cut ‘LPB’

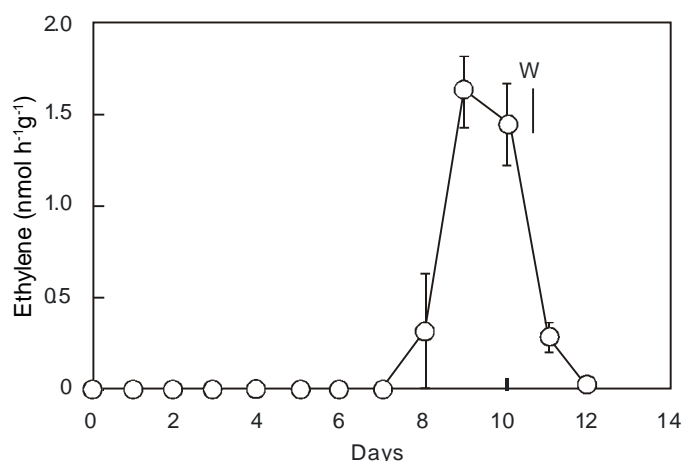


Fig. 1. Change in the ethylene production rate of cut ‘Light Pink Barbara (LPB)’ carnation flowers with single flowers at the fully-open stage on a stem. ‘W’ indicates the time of wilting.

carnation flowers by measuring ethylene production and observing the change in senescence profiles of the flowers. Figure 1 shows the changes in ethylene production of the individual flower that senesced naturally, *i.e.*, without pollination. Ethylene production started on day 8, reached a maximum of 1.64 nmol g⁻¹ h⁻¹ on day 9, and slightly declined to 1.46 nmol g⁻¹ h⁻¹ on day 10, then markedly declined. It is well known that the maximum ethylene production is detected just before or at the onset of in-rolling of petals in naturally-senescing carnation flowers. Actually, the flowers began to show the in-rolling of petals on day 9 and wilted completely on day 10-11. Thus the vase life of the flowers was about 10 days in this experiment. Previously Nukui *et al.* (2004) reported that the vase life of ‘LPB’ flowers varied with the flower samples harvested at different seasons, and the vase life of the flowers harvested in winter season (December – March) tended to be longer than that of those harvested in summer season (late May – September). Regardless of the difference in the time of harvest, however, ‘LPB’ flowers always produced ethylene in a climacteric manner and in similar amounts during natural senescence. In the present investigation, we observed the variation in the time of maximum ethylene production (varied from 5 to 9 days) and the length of vase life (varied from 6 to 10 days) in three separate experiments.

Determination of the vase life by observing the number of open flowers: Data in Fig. 2 show the changes in the percentage of fully-open flowers to the total number of initial flower buds in the cut flowers of ‘LPB’ carnation, which were subjected to natural senescence (control) or pre-treated with 0.1 M sucrose or 0.2 mM DPSS for 7 days. Sucrose was shown to lengthen the vase life of cut carnation flowers (Borochoy and Mayak, 1984; Mayak and Dilley, 1976; Mayak and Kofranek, 1976). DPSS is a potent preservative for cut carnation flowers, which inhibits the onset of ethylene production in the flowers undergoing natural senescence (Midoh *et al.*, 1996; Onoue *et al.*, 2000).

In the control cut ‘LPB’ flowers, the number of fully-open flowers increased rapidly from two days after the start of incubation and

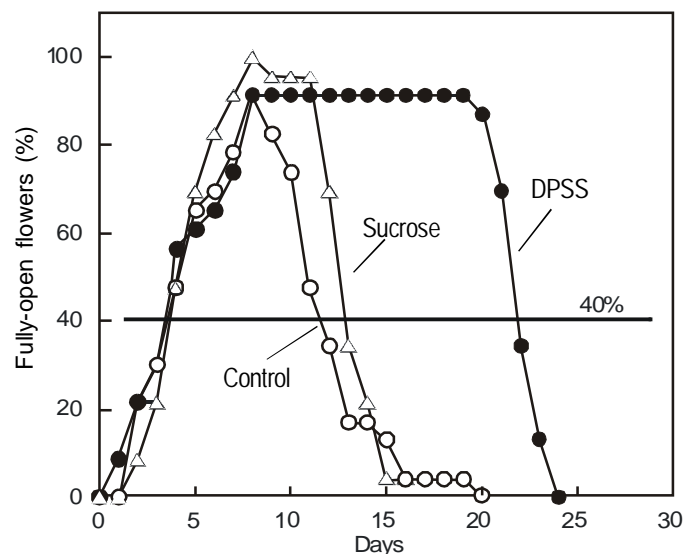


Fig. 2. Changes in the number of fully-open non-senescent flowers in cut ‘LPB’ carnation flowers with multiple flowers on a stem (spray type), pretreated without or with 0.2 mM DPSS and 0.1 M sucrose. Values are percentage of fully-open flowers to the total number of initial flower buds.

became maximum on day 8 (more than 90 % flowers were fully-open and not-wilted), then declined rapidly. Pretreatment with 0.1 M sucrose slightly increased the number of fully-open flowers and delayed their wilting (senescence). DPSS treatment did not affect the time of flower opening, which started from one day after the start of incubation and became maximum on day 8, indicating that DPSS had no inhibitory effect on flower opening of the 'LPB' carnation flowers. However, DPSS treatment markedly delayed the onset of flower senescence.

The control flowers and the flowers treated with sucrose showed in-rolling and wilting of petals, which are typical symptoms of senescence induced by ethylene. On the other hand, the first symptom of petal senescence in the DPSS-treated flowers were desiccation, discolouration and necrosis of the petal margins, which gradually spread to the remaining petal portions. These senescence symptoms were typical for senescence in carnation flowers occurred independent of ethylene action.

When the vase life of cut flower was defined as the period during which 40% or more flowers were fully open, the vase life of the cut flowers was 8 days, from day 4 to day 11 of the incubation period in the control flowers, 9 days ranging from day 4 to day 12 in the flowers treated with sucrose, and 17 days from day 4 to day 21 in the flowers treated with DPSS. In addition, when the vase life was defined as the period during which 50% or more flowers were fully open, it was 6, 8 and 17 days in the control, sucrose-treated and DPSS-treated flowers, respectively.

In the present study, we tried to determine the vase life of cut carnation flowers of the spray type by observing the number of open flowers, *i.e.*, the percentage of open flowers to the total number of initial flower buds. The vase life determined by this method was similar to that determined by measuring ethylene production and observing senescence symptoms of the carnation flowers. In addition, the present method effectively evaluated the action of preservatives, sucrose and DPSS, for carnation

flowers. These findings indicate that the determination of the vase life of the cut carnation flowers of the spray type by observing the number of open flowers is as effective as that by the observation of senescence profiles and ethylene production. Thus, the present method for the determination of vase life can be used as an alternative method for the determination of the vase life of carnation flowers, especially those of the spray type.

References

- Borochoy, A. and S. Mayak, 1984. The effect of simulated shipping-conditions on subsequent bud opening of cut spray carnation flowers. *Sci. Hort.*, 22: 173-180.
- Borochoy, A. and W.R. Woodson, 1989. Physiology and biochemistry of flower petal senescence. *Hort. Rev.*, 11: 15-43.
- Mayak, S. and D. Dilley, 1976. Effect of sucrose on response of cut carnation to kinetin, ethylene and abscisic acid. *J. Amer. Soc. Hort. Sci.*, 101: 583-585.
- Mayak, S. and A.M. Kofranek, 1976. Altering the sensitivity of carnation flowers (*Dianthus caryophyllus* L.) to ethylene. *J. Amer. Soc. Hort. Sci.*, 101: 503-506.
- Midoh, N., Y. Saijou, K. Matsumoto and M. Iwata, 1996. Effects of 1,1-dimethyl-4-(phenylsulfonyl)semicarbazide (DPSS) on carnation flower longevity. *Plant Growth Regul.*, 20: 195-199.
- Nukui, H., S. Kudo, A. Yamashita and S. Satoh, 2004. Repressed ethylene production in the gynoecium of long-lasting flowers of the carnation 'White Candle': role of gynoecium in carnation flower senescence. *J. Exp. Bot.*, 55: 641-650.
- Onoue, T., M. Mikami, T. Yoshioka, T. Hashiba and S. Satoh, 2000. Characteristics of the inhibitory action of 1,1-dimethyl-4-(phenylsulfonyl)semicarbazide (DPSS) on ethylene production in carnation (*Dianthus caryophyllus* L.) flowers. *Plant Growth Regul.* 30: 201-207.
- Reid, M.S. and M-J. Wu, 1992. Ethylene and flower senescence. *Plant Growth Regul.*, 11: 37-43.
- Woodson, W.R., K.Y. Park, A. Drory, P.B. Larsen and H. Wang, 1992. Expression of ethylene biosynthetic pathway transcripts in senescing carnation flowers. *Plant Physiol.*, 99: 526-532.