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Influence of storage temperature on *Epidendrum ibaguense* flowers

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ABSTRACT. The present work was carried out to evaluate the influence of temperature and wet-versus-dry storage on longevity, respiration and ethylene production during storage of *E. ibaguense* flowers. The inflorescences were harvested and stored at 5, 10, 15, 20, 25, 30, 35, and 40ºC, in water or dry, until complete senescence. Respiration increased when inflorescences were treated with wet or dry storage. The Q_{10} factor for this flower, at temperatures ranging from 5 to 40°C, was similar to most fresh horticultural products, varying between 1.2 and 3.31 depending on storage temperature. Production of ethylene by the inflorescence was maximal at 20ºC for flowers maintained in water, and at 35°C for those flowers kept dry, followed by a sharp drop in both treatments. A maximal shelf life for cut flowers was obtained when the inflorescences were stored wet at 10°C. Symptoms of chilling were observed in flowers stored in water after six to seven days at 5°C, showing petal wilting and necrosis of the labellum. At 40°C, flowers stored dry showed severe petal wilting and darkening of bud petals less than one day after harvest.

Keywords: storage, Q_{10} factor, chilling symptoms.

RESUMO. Influência da temperatura de armazenamento em flores de *Epidendrum ibaguense*. O presente trabalho avaliou a influência da temperatura e armazenamento úmido e seco sobre a longevidade, respiração e produção de etileno de flores de *Epidendrum ibaguense*. As hastes foram colhidas, colocadas em vaso e armazenadas em temperatura de 5, 10, 15, 20, 25, 30, 35 e 40ºC, em água ou a seco, até completa senescência das flores. A respiração aumentou quando as inflorescências foram tratadas com armazenamento úmido ou seco. O fator Q_{10} para estas flores, na faixa de temperatura de 5 a 40ºC, foi similar a da maioria dos produtos hortícolas, variando de 1,2 a 3,3, dependendo da temperatura de armazenamento. A produção de etileno foi máxima a 20ºC, para as flores mantidas em água, e a 35ºC para aquelas mantidas a seco, e a partir destas temperaturas houve redução em ambos os tratamentos. A longevidade foi máxima quando mantidas em água a 10ºC. Sintomas de injúria por frio foram observados em flores armazenadas em água após seis-sete dias a 5ºC, indicando murchamento das pétalas e necrose do labelo. A 40ºC, as flores armazenadas a seco apresentaram severo murchamento das pétalas e escurecimento dos botões florais, em menos de um dia de colhidas.

Palavras-chave: armazenamento, fator Q_{10}, sintomas de injúria por frio.

Introduction

Although a large number of tropical ornamental plants have high commercial value as cut flowers, many of these species present short shelf life, which limits the length of storage and vase life. Several biotic and abiotic stresses can affect flower deterioration, including exhaustion of carbohydrate supply, sensitivity to ethylene, xylem obstruction and infection by microorganisms (FINGER; BARBOSA, 2006). *Epidendrum ibaguense* is a naturally ground-grown orchid in the highlands of Brazil, spreading from Amapá to Minas Gerais States. Due to the colorful inflorescence and long stem, this orchid has been used as a new option of cut flower, but it has relatively short vase life, ranging from 5 to 6 days. Little is still known about the physiology of flower senescence and the potential for storage of this species as a cut flower.

The longevity of cut flowers is affected by several environmental and endogenous factors. For most flower species, the use of preservative solutions is recommended to extend vase life. Orchids such as *Phalaenopsis*, *Dendrobium* and *Epidendrum* are sensitive to ethylene. When they are exposed to that hormone, wilting and flower abscission are induced rapidly (FINGER; BARBOSA, 2006; WOLTERING; VAN DOORN, 1988). Prevention of such deleterious effects can be achieved by treating flowers with substances that either inhibit the synthesis of ethylene or block its action. In a previous work, Moraes et al. (2007) determined that *E. ibaguense* is a highly sensitive species to ethylene and inhibitors of its action prolongs vase life, mainly by reducing flower abscission. However, the deleterious affects of ethylene can be reduced by treating the flowers with 1-methylcyclopropene (1-MCP) or silver thiosulphate (STS) immediately after harvest (FINGER et al., 2008). Pollinated cut flowers of *Phalaenopsis*, pre-treated with 1-methylcyclopropene (1-MCP) or kept continuously in silver thiosulphate (STS), had their vase-life extended compared to untreated flowers (PORAT et al., 1995).

Respiration is usually taken as a good indicator of the metabolic rate in fruits, vegetables and flowers. The high respiration rates that prevail in most flowers release large amounts of heat, consumption of carbohydrate reserves and elevated transpiration rates (VAN DOORN, 2001). In addition, higher temperature enhances the loss of fresh weight by the flower during storage (ZENCIRKIRAN; MENGÜÇ, 2003). Low postharvest storage temperatures are crucial to maintain flower quality, but as a tropical species, *E. ibaguense* may develop chilling symptoms during storage. In species like *Heliconia* spp., *Alpinia purpurata* and *Strelitzia reginae*, the critical temperature for development of chilling injury symptoms is usually bellow 10 to 13°C (FINGER et al., 2003; JAROENKIT; PAULL, 2003).

Temperature is considered the most important factor affecting the quality and longevity of cut flowers. Under physiological temperatures, a negative correlation is observed between the increase in temperature and reduction of flower longevity (CEVALLOS; REID, 2000). It has been proposed that the respiration rate can be used as an indicator to predict the longevity of cut flowers, as previously examined in *Narcissus* and *Consolida ajacis*, making it possible to establish mathematical models between storage temperature and vase life (CEVALLOS; REID, 2000; FINGER et al., 2006).

The dry or wet storage method is also a widely used method, where in wet storage, the base of stalks are submerged in water or preservative solution and will lead to short periods of storage. Already in storage to dry, the flowers are not in solution and are designed for long periods of storage (RUDNICK et al., 1991). However, the effect of storage type is variable and dependent on temperature. Cevallos and Reid (2000) confirmed the hypothesis that the benefits of wet storage are only observed in *Narcissus tazetta* when the flowers are kept in temperatures above 10°C. Joyce et al. (2000) observed that flowers of *Grevillea* 'Sylvia' had greater vase life when stored dry at 0°C, possibly due to increased metabolism during wet storage. However, Bunya-Atichart et al. (2004) observed that dry storage, even over short periods, was harmful to the flowers of *Curcuma alismatifolia*; however, the wet storage to prevent excessive loss of water and the flowers kept at 10ºC had a normal vase life.

The present work investigate the influence of temperature and wet versus dry storage on longevity, respiration and ethylene production during storage of *E. ibaguense* flowers.

Material and methods

Stalks of *E. ibaguense* flowers were taken from the garden field located at the Federal University of Viçosa (20º45’ S; 42º51’ W; 642 m a.s.l.) when the inflorescences had at least 20 fully-open flowers (FINGER et al., 2008). The stalks were immediately taken to the laboratory, trimmed to 25 cm-long stems and stored in growing chambers at 5, 10, 15, 20, 25, 30, 35 and 40°C. For the wet storage, the water in the vase was changed after cutting the base of the stem every two days in a growth chamber with 75% relative humidity at PAR of 10 μmol m^{-2} s^{-1} illuminated by cool white fluorescent lamps. The same conditions of relative humidity and light were used for dry storage of flowers.

Flower respiration and ethylene production were determined daily for four days beginning 24 hours after harvest, in individual stalks placed in one-liter closed flasks. The average values used since remained constant over time in each time of exposure. After a period of 6 hours, samples were withdrawn from the internal atmosphere of the flasks for the measurement of CO_2 and ethylene. Carbon dioxide and ethylene were separated in a column Porapak-Q at 60°C using a GC-14B (Shimadzu, Japan) equipped with a thermal conductivity and flame ionization detector.

The Q_{10} factor for respiration was estimated as described by Wills et al. (1998) The end of vase life was established when at least 50% of the flowers had fallen or wilted (MORAES et al., 2007).

In the experiment, flowers were arranged in a complete randomized design with a total of five replications per treatment, containing three inflorescences per replicate.

Results and discussion

When stored in vases containing water, the flowers showed linear increase (R = 0.98) in respiration between temperatures of 5 and 30°C. In these flowers, respiration rates varied from 56 mL CO_2 kg^{-1} h^{-1} at 5°C to maximal of 235 mL CO_2 kg^{-1} h^{-1} at 30°C (Figure 1A). On the other hand, in flowers stored under dry condition, the increase in respiration was exponential (R = 0.95) between the temperatures of 5 and 25°C, with similar rates to those determined in wet stored flowers (Figure 1C). A small drop in flower respiration was determined when temperature was increased to 35 and 30°C for wet and dry storage, respectively, and higher temperatures up to 40°C stimulated CO_2 production (Figures 1A and C). Respiration rates in this cut flower are much lower than those determined in *Consolida ajacis* inflorescences (FINGER et al., 2006).

For flowers stored in water, the Q_{10} values varied from 1.2 at temperature ranging from 35 to 40°C and maximum of 2.6 between 10 to 15°C. Flowers kept in the dry had similar behavior for the Q_{10} factor, ranging from 1.3 between 5 to 10°C to 3.3 from 15 to 20°C. The Q_{10} factor for this flower, at temperatures ranging from 5 to 40°C, was similar to most of the horticultural products. In narcissus flowers, the maximal Q_{10} of 3.7 was close to *E. ibaguense* (CEVALLOS; REID, 2000), but much lower than the values found in roses and carnations (WILLS et al., 1998). In another work, Finger et al. (2006) working with *Consolida ajacis* inflorescences kept in vase with water, found a similar influence of temperature on the respiration and Q_{10} values, but with a much higher CO_2 production, about 7 to 8-fold greater than *E. ibaguense*. Thus, for this flower, wet or dry storage had little influence either on the pattern of CO_2 production or on Q_{10} values for respiration if compared to changes induced by the temperature of storage.

Production of ethylene was maximal at 20°C for flowers maintained in water and 35°C for flowers kept dry, followed by a sharp drop in both treatments (Figure 1A and C).

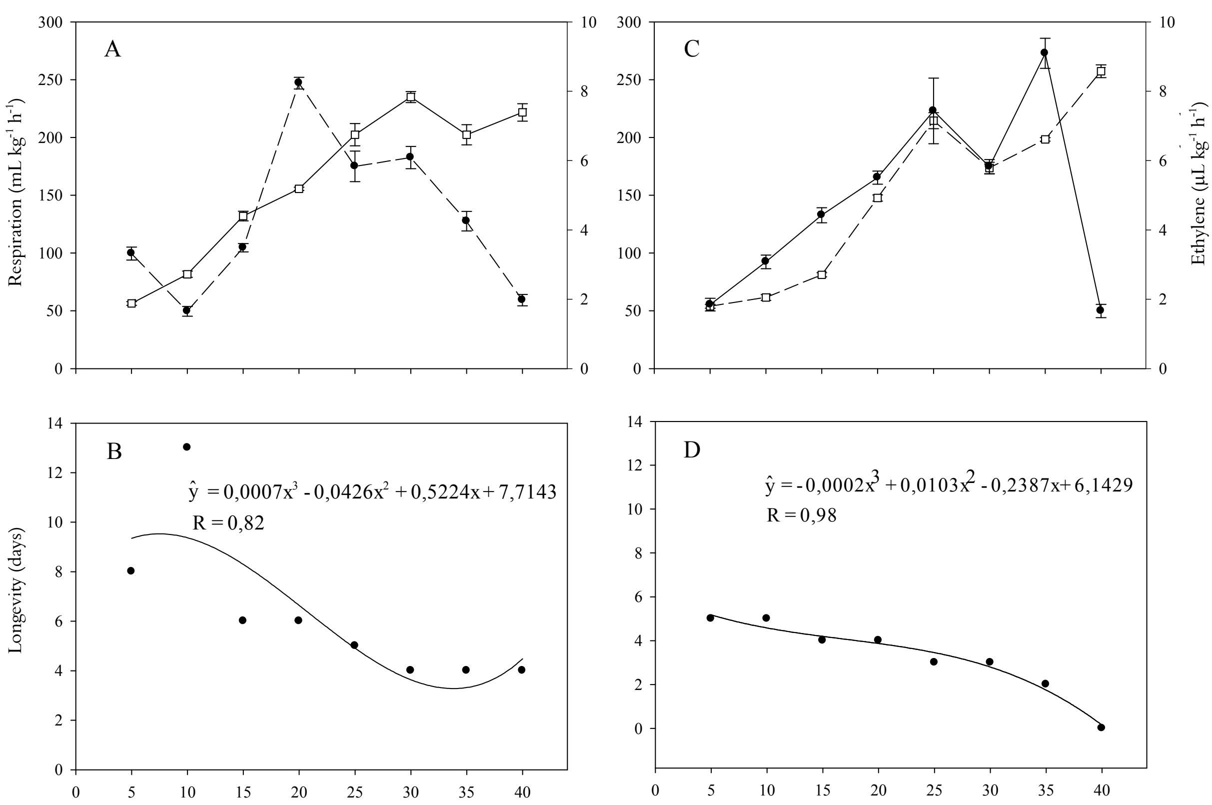

Figure 1. Respiration (□), ethylene production (●) and longevity of *Epidendrum ibaguense* flowers stored in wet (A and B) and dry (C and D) conditions at different temperatures. Means of the measurements ± SE.

For flowers kept in water, the ethylene production was at 5°C than in 10°C, which might be associated with the development of chilling injuries observed in flowers stored below 10°C (Figure 2).

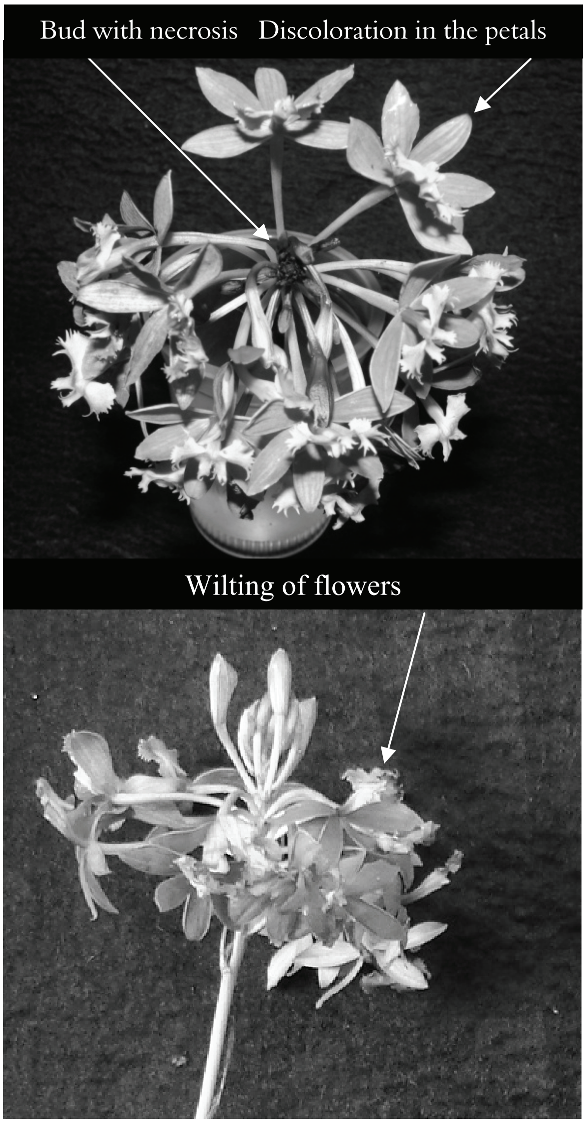

Figure 2. Symptoms of chilling and senescence of *Epidendrum ibaguense* inflorescences stored wet and dry at 5ºC (A) and 10°C (B).

The relationship between temperature and respiration rate on the longevity of flowers has been established in several previous works. In flowers of *Narcissus*, a negative linear correlation was observed between respiration and longevity (CEVALLOS; REID, 2000), while in *Consolida ajacis* inflorescences the relation between temperature and longevity followed an inverse cubic model (FINGER et al., 2006). Also, the best model that explains the influence of temperature on the longevity of *E. ibaguense* was negative cubic model, for both, in wet and dry stored conditions (Figure 1B and D). The maximal longevity of flowers was obtained when the inflorescences were stored wet at 10°C, reaching 13 days to lose or wilt at least 50% of the flowers (Figure 1B). But when stored dry, the flowers had a longer longevity of 5.5 days, either at 5 or 10°C (Figure 1D).

Longevity of flowers stored in water was increased from 5.2 to 9.4 days when temperature was reduced from 40 to 10°C (Figure 1B). Although the behavior of respiration between the wet and dry storage was similar, the longevity of the later was much lower. In these flowers, maximal longevity was obtained at 5°C, with an estimated longevity of 5.5 days and 0.27 days at

40°C (Figure 1D). The shorter shelf life observed in dry storage seems to be associated to faster wilting, as be seen in the description of senescence in both storage systems (Tables 1 and 2). Clearly at 40°C, an intense dehydration reduced the self life to less than a day, while for the wet storage condition only at third day appeared symptoms of senescence, which was characterized by discoloration and necrosis of labellum, but no visual detectable wilting of petals or necrosis of labellum were present.

Table 1. Time and symptoms of *Epidendrum ibaguense* orchid senescence in wet storage at different temperatures.

Temperature (°C)	Time (days)	Symptoms description
		Wet storage
5	Sixth	Flowers wilted
	Seventh	Labellum with necrosis
10	Tenth	Flowers with discoloration in the petals
	Twelfth	Labellum with necrosis
15	Sixth	All labellum from the flowers orange
	Eleventh	Presence of discoloration in the petals
20	Fourth	Labellum orange, presence of discoloration in the petals
25	Fourth	Labellum orange, presence of discoloration in the petals
30	Fourth	Labellum orange, presence of discoloration in the petals
35	Third	Beginning of petal discoloration
40	Third	Discoloration of petals, necrosis of labellum

Table 2. Time and symptoms of *Epidendrum ibaguense* orchid senescence in dry storage at different temperatures.

Temperature (°C)	Time (days)	Symptoms description
		Dry storage
5	Fourth	Discoloration in the petals, orange labellum
10	Fourth	Discoloration in the petals, orange labellum
15	Third	Discoloration in the petals, orange labellum
20	Third	Discoloration in the petals, orange labellum
25	Second	Beginning of petal discoloration, wilting of labellum
30	Second	Petal discoloration, wilting of labellum
35	Second	Intense discoloration of petals, labellum orange
40	0.75	Complete wilting of the flowers, dark floral buds

Conclusion

The temperature of 10°C improved condition for the storage of the flowers of *Epidendrum ibaguense*. The flowers of *Epidendrum ibaguense* showed desirable characteristics when kept in water. Symptoms of chilling were observed in flowers stored in water after six to seven days at 5°C. At 40°C, flowers stored dry had shown severe petal wilting and darkening of bud petals.

Acknowledgments

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References

BUNYA-ATICHART, K.; KETSA, S.; VAN DOOR, W. G. Postharvest physiology of *Curcuma alismatifolia* flowers. **Postharvest Biology and Technology**, v. 34, n. 2, p. 219-226, 2004.

CEVALLOS, J. C.; REID, M. S. Effects of temperature on the respiration and vase life of *Narcissus* flowers. **Acta Horticulturae**, v. 517, n. 1, p. 335-341, 2000.

FINGER, F. L.; BARBOSA, J. G. Postharvest physiology of cut flowers. In: BENKEBLIA, N.; SHIOMI, N. (Ed.). **Advances in postharvest technologies for horticultural crops**. Kerala: Research Signpost, 2006. p. 373-393.

FINGER, F. L.; MORAES, P. J.; BARBOSA, J. G.; GROSSI, J. A. S. Vase life of bird-of-paradise flowers influenced by pulsing and term of cold storage. **Acta Horticulturae**, v. 628, n. 1, p. 863-867, 2003.

FINGER, F. L.; MORAES, P. J.; MAPELI, A. M.; BARBOSA, J. G.; CECON, P. R. Longevity of *Epidendrum ibaguense* flowers as affected by pre-loading treatments and vase solution. **Journal of Horticultural Science and Biotechnology**, v. 83, n. 2, p. 144-147, 2008.

FINGER, F. L.; SANTOS, V. R.; BARBOSA, J. G.; BARROS, R. S. Influência da temperatura na respiração, produção de etileno e longevidade de inflorescências de esporinha. **Bragantia**, v. 65, n. 3, p. 363-368, 2006.

JAROENKIT, T.; PAULL, R. E. Postharvest handling of *Heliconia*, red ginger and bird-of-paradise. **Horttechnology**, v. 13, n. 2, p. 259-266, 2003.

JOYCE, D. C.; MEARA, S. A.; HETHERINGTON, S. E.; JONES, P. Effects of cold storage on cut *Grevillea* 'Sylvia' inflorescence. **Postharvest Biology and Technology**, v. 18, n. 1, p. 49-56, 2000.

MORAES, P. J.; FINGER, F. L.; BARBOSA, J. G.; CECON, P. R. Longevidade pós-colheita da orquídea *Epidendrum ibaguense*. **Revista Brasileira de Horticultura Ornamental**, v. 13, n. 1, p. 31-37, 2007.

PORAT, R.; HALEVY, A. H.; SEREK, M.; BOROCHOV, A. An increase in ethylene sensitivity following pollination is the initial event triggering an increase in ethylene production and enhanced senescence of *Phalaenopsis* orchid flowers. **Physiologia Plantarum**, v. 93, n. 1, p. 778-784, 1995.

RUDNICKI, R. M.; NOWAK, J.; GOSZCZYNSKA, D. M. Cold storage and transportation conditions for cut flowers cuttings and potted plants. **Acta Horticulturae**, v. 298, n. 1, p. 225-236, 1991.

VAN DOORN, W. G. Role of soluble carbohydrates in flower senescence: a survey. **Acta Horticulturae**, v. 543, n. 1, p. 179-183, 2001.

WILLS, R.; MCGLASSON, B.; GRAHAM, D.; JOYCE, D. **Postharvest**: an introduction to the physiology and handling of fruit, vegetables and ornamentals. Wallingford: CAB International, 1998.

WOLTERING, E. J.; VAN DOORN, W. G. Role of ethylene in senescence of petals-morphological and taxonomical relationships. **Journal of Experimental Botany**, v. 39, n. 208, p. 1605-1616, 1988.

ZENCIRKIRAN, M.; MENGÜÇ, A. Cold storage of *Alstroemeria pelegrina* 'Ostara'. **New Zealand Journal of Crop and Horticultural Science**, v. 31, n. 1, p. 255-259, 2003.

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