**Echeveria gibbiflora** D. C. – A New Ornamental Plant from Mexico. I. Vase Life

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**Abstract**
Experiments were conducted with cut flowering stems of Estrella del Coral (Coral Star) (**Echeveria gibbiflora** DC). The aim was to explore the feasibility of keeping the stems in dry or wet vase and storing the stems under dry conditions, wrapped in paper in a semi-dark room. Later, the dry stored stems were placed in a dry or wet vase. The basal part of the stem showed the highest losses in water with ensuing collapse of the stem; which was more frequent in the southern window. The bracts did not modify the water status of flowering stems. Their removal at harvest is recommended. The daily water loss was low and varied from 1.0 to 3.6 g in four weeks. The hydration of dry matter (g H₂O · g⁻¹ m. s.) in the dry stored flowering stem was: stem apex>lateral inflorescence>stem base, whereas in freshly harvested material stem base>stem apex>lateral inflorescences. The number of flowers opened in five weeks varied from 9 to 44 per stem. The average number of open flowers per one lateral, in one week was 1.2. The aesthetic value of the flowering stem is determined by the number of flowers, closed buds, closed flowers, peduncles appearing weekly per stem and the red color of the stem. The vase life is limited by the relatively early collapse of the stem. The stored stems should be kept vertically. The dry storage conditions should be determined in the future.

**INTRODUCTION**
The genus *Echeveria* was used for production of potted plants or for gardening and no mention was found about their use for cut flower production (Bailey, 1953; Nowak et al., 1990). Formerly two Crassulacean Acid Metabolism (CAM) species were presented for their aesthetic and postharvest values as cut flowers – the *Bryophyllum tubiflorum* Harv. and the *B. pinnatum* Kurz (Leszczyńska-Borys and Borys, 1997; Leszczyńska-Borys et al., 2002 a, b). The *E. gibbiflora* is the third of the CAM group of species proposed as cut flower.

The succulent aspect and CAM metabolism of *Echeveria gibbiflora* supports the idea that its flowering stem could be used without rapid loss in flower quality and suggests that the postharvest growth of lateral inflorescences guarantees a continuous flower production. The main objective of this report was to test this assumption.

**MATERIALS AND METHODS**

The flowering stems were harvested October 26, 1999 at random from plants grown at the UPAEP germplasm collection and stored dry until December 11, 1999. The investigation on this species continues.

Stems wrapped in newspaper were inserted in plastic bags. The bases of stems were uncovered. These stems were kept in a horizontal position in a semi-dark room throughout the storage period. The storage temperature was 16-18°C. These stems were used to study their vase life from December 12, 1999 till January 16, 2000. The main objective of this study was to test the survival time of the dry stored stems (from 26.10.03

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till 12.12.03) and post-storage flowering, that is, generation of flowers once the stored stems were transferred to a normal room and placed in a flower vase either with water (wet-vase) or without (dry-vase). Vase life evaluation was run from 12.12.99 until 17.01.00 – treatments 1, 2, 3 (Table 1). The flowering, judged by the number of flowers formed during this period was compared to freshly cut stems (treatments 4, 5; Table 1). The stems kept in wet vase were recut weekly; tap water was used. This study was conducted at 16-18°C and a relative humidity of 82-72% (Night/Day). Seven stems were used per treatment (replication). One stem constituted the experimental unit. This vase life study lasted as indicated in the Table 1. Upon these stems the number of open flowers was related to the length of lateral inflorescences (Fig. 1 and 2).

In other treatments from two to nine stems were used. Lower number of stems were applied to determine the mass of flowers and the loss in fresh mass of opened flowers (Table 3). These experiments were conducted at 16-18°C and a relative humidity of 82-72% (Night/Day).

The loss of water (% of the initial stem mass) during the vase life study was calculated by the difference in fresh mass (Table 2). The factors studied were: wet-vase x dry vase, bracts present x bracts removed, N x S rooms window exposition.

The hydration coefficient was studied in two parts of the flowering stem by taking 10 cm long samples of each stem, one below the point where the first lateral inflorescence emerged (stem base) and the second where all lateral inflorescences were present (stem apex). These stems were dried at 70°C for 48 hours to define the mass of water as well as the dry mass at the end of experiment.

To test the possibility of storing the stems by small growers, lacking storage facilities, the flowering of freshly cut stems, exposed to the open sky (full sun and under the shade of a wall) was compared to flowering of stems inside a room (3 factors), interacting with the dry and wet vase (2 factors) and stems with and without bracts (2 factors). Five stems were used in treatments without bracts and nine stems in treatments with bracts. The higher number of stems with bracts were applied due to high tendency of bracts breaking away as well as rapid loss in turgidity of bracts (Fig. 3, 4).

RESULTS AND DISCUSSION

Data reported include visual observations and conclusions reached from the measurements taken.

Flowers Development in Dry Stored Stems

The prime objective was to test the length of time the stored stems will be able to survive, to grow and to support flowers formation and their opening. The extension growth of lateral inflorescences continued although the stems were stored dry for extremely long time and still they were able to produce new flowers. The results (Table 1) indicate that the dry storage is feasible and that the extended dry storage did not modify the flowering compared to freshly cut stems. The flowers from stored stems were of inferior quality. The average number of opened flowers per stem varied 14 to 19.8 weekly. The laterals of dry stored stems were growing continuously. Thus, being longer they gave higher number of flowers compared to laterals of freshly cut stems (Fig. 1, 2).

In another test stems were held in plastic bags with perforated bottom to remove precipitated water, in vertical and horizontal position under open sky but shaded. The results showed that for up to two weeks stems can be stored in vertical position securing stem quality to supply the consumers stems of good vase life. Stems should not be exposed to direct sunlight. Longer storage may deteriorate the quality of stems. The stems should be stored only in vertical position to avoid faulty of lateral inflorescences resulting from tropic growth.

Vase Life of Freshly Cut Stems

Small growers do not have cooling facilities. Thus, storing flowering stems under shade, under open sky or inside room should be a simple solution. Results (Fig. 3, 4)
indicate that the best flowering was secured in stems held under shade in the open sky (ambient effect F=8.10, P=0.000; Fig. 3). There was no significant difference in flowering by stems held in full sunlight and in a room. There was no main effect of the dry or wet-vase or no interaction of both with the remaining factors. Stems held in the direct sun gave flowers of lower mass by 30 to 50% during 30 days of observations. There was no significant effect of dry or wet-vase on flowering although there was significant effect of interaction of ambient with bracts (F=5.23, P=0.007; Fig. 4). The effect of bracts and of dry wet vase conditions on flowering were confirmed.

The size of flowers was modified slightly by the time of harvest of stems, being 461 mg flower\(^{-1}\) in November to January and 429 mg \cdot flower\(^{-1}\) at the beginning of March (F= 8.30, P= 0.001).

**Bracts Presence or Removal**

The general stem aesthetics were affected by bracts heavily covering the stem, which are damaged and even drop easily. Bracts increase the stem weight. In general bracts formed an obstacle to stems handling. Bracts were without modifying effect upon the water content of stems (Table 2) and presented only slight significant interaction with environment on flowering (Fig. 4; F=5.23, P=0.007).

**Continuity of Flower Production by Stems Held in a Dry or Wet Vase**

In general there was no difference in the number of flowers developed per unit of time and a lateral inflorescences in stems kept without water or in vase with water. The average number of flowers opened was practically constant throughout the whole period of observations which was illustrated by the first regression model in Table 3. The fresh mass of an opened flower was diminishing continuously as illustrated by the third regression model in Table 3. Fifty per cent of flowers per stem was located in the range of sizes from 300 to 400 mg \cdot flower\(^{-1}\) with some flowers exceeding 500 mg. The inflorescence was producing flowers of very good quality up to 4 to 6 weeks keeping stems in higher humidity and temperatures not exceeding 20\(^\circ\)C. Stems kept in dry vase were not affected by the decay of parenchyma. Rotting of stems was frequent in wet-vase and southern window exposition. Stems kept dry and in southern exposition collapsed within two weeks.

**Flowering of Cut Stems – the Vase Life**

The number of flowers developed per lateral inflorescence and per stem is very low and depends on the length of laterals (Fig. 1, 2) and the degree of their ramification. It was noted that strong inflorescences were giving the second and third ramification leading to increased number of open flowers per lateral. The vase life is shorter when stems have been stored for a long time and is longer when the customer is supplied with freshly cut stems. The vase life of stems kept in dry vase, securing good aesthetic quality oscillated from 2-3 to 4-6 weeks.

**Water Status of Flowering Stems**

Bracts had no significant effect on the water content of cut stems. The stem water content was higher in northern windows compared to southern one with incoming sunlight. Lower losses of water by stems held in vases with water was noted in stems held in northern window and no difference between stems held in dry or wet vases was found in stems held in the southern window (Table 2). The southern exposition in stems held in dry vase prompted drying whereas in stems held in wet-vase promoted the decay of parenchyma, reducing the water holding capacity of the stem. There was no apparent relation between the water held by the stem and the number of flowers developed but the size of flowers was always lower in stems from dry vase, stems held in windows of southern exposition and stems held under open sky and in full sunlight. There was no measurable water uptake by the cut stems.

All the parenchyma of stem’s base, that is below the first lateral inflorescence and
of the part of the stem where all lateral inflorescences are present (stem apex), was saturated with water. The mean relation of mass of water to dry mass (hydration of stems) of stems base, stems apex and of lateral inflorescences was 5.663, 6.352, 4.974, respectively. The highest hydration of stems apex suggests that this part may constitute a water reservoir for the laterals. The lower hydration of laterals may be related to water losses by flowers which are losing rather high amount in fresh mass as illustrated by respective regression (Table 3). The hydration coefficient of stem’s basal part of freshly harvested stems was 6.449 of stems held in dry vase or under the open sky 3.971.

Neither the water loss by the flowering stem components, nor the lack of water uptake by the stem could be related to the continued flower production by lateral inflorescences. The relative high hydration of this stem component suggests the presence of some water conservatory mechanism which conditions the long lasting presentation of flower development.

The small land owners most of the time can not get modern storage equipment for cut flowers. However, they can take advantage of existent environmental conditions and simple, cheap technical means – shaded areas, plastic bags, seasonal low temperature – at their disposal. The *E. gibbiflora*, one of many CAM plants may comply with these requirements. The use of transparent plastic bag to reduce transpiration, the use of shaded areas under the open sky are the cheap means available to the grower may extend the utility time of cut inflorescences or/and to conserve the stems aesthetic value until the time of shipment. The CAM plants, having natural water conservatory mechanisms (Barrs, 1971; Zabka and Chaturvedi, 1975; Wang and Lin, 1987) seems to produce inflorescences with extended storage and vase life. The continued and long lasting flowering of cut stems of *E. gibbiflora*, held in dry vase or wet vase, under the open sky or in the interior support the idea that CAM plants could be used successfully as ornamental item in ambient horticulture. The successful flowering of stems held in dry vase is in itself of interest to consumers. Data suggests that lateral inflorescences present properties which allow for continued growth extension and flowers development in laterals for few weeks.

**CONCLUSIONS**

The *E. gibbiflora* produces large inflorescences. The stems can be stored dry and can be kept dry or in a vase with water for a few weeks without substantial loss in aesthetic value. The aspect of dry keeping is of interest to small land-owners, to flower designers, where large stems are desired without the use of water. The flowering stems of this species offer an alternative or complementary commodity to the existing species of extended vase life, especially the dry vase flowers.

**Literature Cited**


274

**Tables**

Table 1. Flowering state of cut stems at the end of experiments – number of buds, open and closed flowers per stem.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Stage of flower development</th>
<th>Buds</th>
<th>Open flowers</th>
<th>Closed flowers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Dry storage from 26.10 to 12.12.99; from 12.12.99 to 16.1.00 in dry-vase; N-exposition.</td>
<td></td>
<td>52.21 a</td>
<td>10.07 b</td>
<td>37.72 a</td>
</tr>
<tr>
<td>2. Dry storage from 26.10.99 to 12.12.99; from 12.12.99 to 16.1.00 in wet-vase; S-exposition.</td>
<td></td>
<td>51.43 a</td>
<td>4.76 a</td>
<td>43.98a</td>
</tr>
<tr>
<td>3. Continuous dry storage; semi-dark from 26.10.99 to 16.1.00.</td>
<td></td>
<td>50.45 a</td>
<td>12.66 b</td>
<td>36.89 a</td>
</tr>
<tr>
<td>4. Freshly cut; from site N (18.1.00).</td>
<td></td>
<td>48.92 a</td>
<td>10.95 b</td>
<td>40.14 a</td>
</tr>
<tr>
<td>5. Freshly cut; from site S (18.1.00).</td>
<td></td>
<td>62.94 a</td>
<td>9.06 ab</td>
<td>28.01 a</td>
</tr>
</tbody>
</table>

F | 1.65 | 8.35 | 1.45 |
P | .188 | .000 | .245 |

a, b = Tukey’s pairwise comparison of treatments.

Table 2. Effect of bracts on water loss of flowering stems kept in or without water and under N and S windows (1999/2000) during 32 days.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Total water lost (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (+) H₂O; (+) Bracts; N</td>
<td>37.36 cd</td>
</tr>
<tr>
<td>2 (-) H₂O; (+) Bracts; N</td>
<td>46.87 be</td>
</tr>
<tr>
<td>3 (+) H₂O; (-) Bracts; N</td>
<td>33.72 d</td>
</tr>
<tr>
<td>4 (-) H₂O; (-) Bracts; N</td>
<td>45.25 c</td>
</tr>
<tr>
<td>5 (+) H₂O; (+) Bracts; S</td>
<td>58.51 ab</td>
</tr>
<tr>
<td>6 (-) H₂O; (-) Bracts; S</td>
<td>60.04 a</td>
</tr>
</tbody>
</table>

Values followed by different letters are significantly different at P=0.000 as determined by Tukey’s pairwise components.
Table 3. Regressions related to some characteristics of inflorescences kept in dry vase.

<table>
<thead>
<tr>
<th>Related variables</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous (y) flowers production of freshly cut stems (number of flowers lateral inflorescence $^{-1}$ day $^{-1}$) during 38 days</td>
<td>.248</td>
</tr>
<tr>
<td>$y = 30.0381 - 1.2068 \text{ days} + 0.0186049 \text{ days}^2$</td>
<td></td>
</tr>
<tr>
<td>Mass of flowers opened (y) (mg · flower $^{-1}$) during 38 days</td>
<td>.745</td>
</tr>
<tr>
<td>$y = 370.349 - 4.45156 \text{ days}$</td>
<td></td>
</tr>
<tr>
<td>Loss in fresh mass of an open flower (y) (mg · flower $^{-1}$) during 44 hours</td>
<td>.595</td>
</tr>
<tr>
<td>$\log y = 0.439199 - 0.0064674 \text{ hours}$</td>
<td></td>
</tr>
</tbody>
</table>

**Figures**

![Graph showing the relationship between open flowers and length of lateral inflorescence.](image)

Fig. 1. Number of opened flowers related to the length of lateral inflorescence.
Fig. 2. Length of lateral inflorescence as related to the number of flowers developed.

\[ Y = 24.16 + 11.05X; \quad R^2 = 51.1\% \]

Fig. 3. Number of flowers produced per stem. There was no significant effect of dry or wet vase on flower development. (Ambient effect F=8.10, P=0.000)

Fig. 4. Number of flowers produced per stem. There was no significant effect of dry or wet vase on flower development (Bracts interaction with ambient F=5.23, P=0.007).