

MATURITY AT HARVEST AFFECTS POSTHARVEST LONGEVITY OF CUT *CALATHEA* FOLIAGE

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ABSTRACT

Foliage of *Calathea aemula*, *C. lietzei* and *C. zebrina* at four maturity stages, first, second, third and fourth fully expanded leaves (FEL) from the shoot apex, were subjected to vase life assessment in distilled water at 20 °C and 70% RH. Leaf rolling was the factor leading to vase life termination. Chlorophyll content significantly decreased during vase life in all three species. The best harvesting maturity in relation to vase life varied among the species. At the time of harvest, chlorophyll content of the 1st FEL were significantly less than those of the 4th FEL in all three species. However, the chlorophyll content at harvest did not show a significant correlation with subsequent *Calathea* vase life.

Key words: chlorophyll, vase life, leaf rolling

INTRODUCTION

Genus *Calathea* (Family: Marantaceae) is native to tropical America and grows best in their native habitat as under-storey plants in humid jungles. *Calathea* foliage produces colour even under extremely low light and are therefore very popular. Of the cut foliage varieties exported from Sri Lanka, cut foliage of *Calathea* species has a good demand (pers. comm. with local cut foliage exporters). At present *C. zebrina*, *C. insignis*, *C. ornata* and *C. musaica* are exported from Sri Lanka. Wilting and rolling of leaves leading to short shelf life are the prominent postharvest problems encountered with *Calathea*. These problems limit the export potential of many attractive *Calathea* species grown in Sri Lanka.

Harvesting maturity, in the context of commercial maturity is concerned with the timing of harvest to meet particular market requirements (Wills *et al.*, 1998). The correct stage of maturity at harvest is one of the key factors to be considered in order to preserve and prolong the postharvest life of cut foliage (Dole and Wikins, 1999). There is no published information related to harvesting maturity of *Calathea* spp. and also, there are no specific guidelines available for exporters regarding the correct harvesting maturity. This paper reports the effects of harvesting maturity on the

postharvest foliage longevity in three selected species of *Calathea*.

MATERIALS AND METHODS

Plant Material

Healthy first (L₁), second (L₂) third (L₃) and fourth (L₄) fully expanded leaves (FEL) from the shoot apices of *C. lietzei* E. Morren, *C. zebrina* (Sims) Lindl. and *C. aemula* Körn. were collected from the Royal Botanic Gardens, Peradeniya, Sri Lanka. The leaves were harvested around 9.00 - 9.30 a.m. using a disinfected secateurs. Cut ends of collected leaves were kept immersed in tap water during transportation to the laboratory. The leaves were wiped with cotton swabs moistened with tap water to remove debris and trimmed to a uniform petiole length (10-15 cm). The trimming was done under tap water to avoid trapping air bubbles (Dole and Wikins, 1999). Individual leaves of each species were placed in glass containers (11 cm tall × 7 cm diameter) filled with distilled water to 10-15 cm height. The vase life experiments were conducted at 20 °C and 70% RH under 24 h/day cool-white fluorescent lighting.

Experimental Design

Treatments were arranged in a Completely Randomized Design (CRD) with eight replicate

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leaves for each maturity stage. The experiment was repeated twice.

Assessments

The leaves were assessed for vase life and chlorophyll content. For vase life assessment, observations were made at two-day intervals after harvest. A self-prepared scale was used to assess the quality of leaves based on freshness (wilting/rolling) and colour as follows: Fresh appearance/No blemish = 4; Slight loss in freshness/Slight yellowing = 3; Moderate loss of freshness/Moderate yellowing = 2; Severe loss of freshness/Severe yellowing = 1. The shelf life was determined as the number of days taken to reach scale 3.

The chlorophyll content of each leaf was measured non-destructively using a digital chlorophyll meter (SPAD 502 / Spectrum Technologies) soon after harvest and at the end of vase life. The leaf tip was selected as the site for chlorophyll measurement since the first signs of yellowing appear in that region. The change in chlorophyll content during vase life was calculated for each cut leaf by subtracting the chlorophyll content at the end of vase life from that at the time of harvest.

Data Analysis

The data were analyzed using Statistical Analysis Software (SAS, 1990). The vase life data were analyzed by one-way ANOVA. Data related to chlorophyll content was subjected to two-way ANOVA. Mean separation was accomplished using the least significant difference (LSD). Relationship between the vase life and chlorophyll content at harvest was tested using Pearson's correlation analysis. Data of the duplicate trials gave similar values for the parameters tested. Data related to only one trial is presented here.

RESULTS

Vase life

In *C. aemula*, the second and third fully expanded leaves (L_2 and L_3) exhibited a significantly higher ($P < 0.05$) vase life than the first fully expanded leaves (L_1) (Table 1). In *C. lietzei*, the lowest vase life (5 days) was observed in L_4 whereas L_3 exhibited the highest vase life of 14 days. In *C. zebrina*, a significantly higher ($P < 0.05$) vase life was exhibited by the first fully expanded leaf (L_1) compared to more mature leaves. However, the other maturity levels of *C. zebrina* showed a relatively shorter vase life than the other two species tested (Table 1). In all three varieties, the leaves started to roll from their leaf margins before any symptom of yellowing became evident.

Chlorophyll content

In all three species tested, the 1st FEL (L_1) contained the least chlorophyll content at the time of harvest (Table 2). Generally, the mean chlorophyll content of the highest mature leaf (L_4) was significantly ($P < 0.05$) higher than that of L_1 . The chlorophyll content of leaves decreased significantly ($P < 0.05$) during vase life in all three species tested irrespective of the harvesting maturity. The only exception to this pattern was shown by the L_1 leaves of *C. zebrina*, where an increase in chlorophyll content was evident by the end of the vase life. Moreover, there was no significant difference in the degree of chlorophyll degradation among leaves of different maturity stages during the vase life except for L_1 leaves of *C. zebrina* (Table 2).

A correlation analysis was carried out to test the association between vase life and chlorophyll content at harvest. All three species exhibited a weak correlation (Correlation coefficient = 0.12, -0.078 and -0.009 for *C. lietzei*, *C. zebrina* and *C. aemula*, respectively) for the two factors. None of the Correlation coefficient values were significant ($P < 0.05$).

Table 1. Mean vase life of *Calathea* spp. with respect to maturity at harvest.

Species	Vase life (Days)*			
	L_1	L_2	L_3	L_4
<i>Calathea aemula</i>	7.25 b	11.44 a	10.50 a	9.20 ab
<i>Calathea lietzei</i>	9.90 ab	8.80 b	14.00 a	5.00 b
<i>Calathea zebrina</i>	15.00 a	7.30 b	5.00 b	5.20 b

*Mean values within a row followed by different letters are significantly different at $P \leq 0.05$ using Duncan's Multiple Range Test ($n = 8$).

Table 2. Chlorophyll content of cut leaves harvested at different maturity stages at the end and start of vase life.

Species		Chlorophyll content (SPAD Units)*			
		L ₁	L ₂	L ₃	L ₄
<i>Calathea aemula</i>	Start	52.31Aa	56.48Ab	54.87Aab	58.56Ab
	End	37.57Ba	45.22Bb	43.95Bab	46.26Bb
	Difference	14.70a	14.19a	10.92a	13.30a
<i>Calathea lietzei</i>	Start	44.32Ab	57.05Aa	58.21Aa	55.27Aa
	End	40.87Bb	50.90Ba	40.47Ba	44.21Ba
	Difference	17.80a	10.40a	9.10a	11.03a
<i>Calathea zebrina</i>	Start	34.26Aac	35.03Ac	36.70Ac	39.80Ad
	End	37.00Ba	25.83Bb	28.30Bb	26.73Bb
	Difference	-2.70a	12.80b	12.46b	13.06b

*Mean values within a column for each species, followed by different letters are significantly different at $P \leq 0.05$ using Least Significant Difference (LSD). Uppercase letters denote significance between Start to End values and the lowercase letters denote significance among maturity stages ($n = 8$).

DISCUSSION

The best maturity stage for harvesting varied among the *Calathea* species tested. This observation agrees with many other ornamental crops that have been studied (Dole and Wikins, 1999). The findings further indicate that vase life experiments are useful in identifying the best maturity stage for harvesting of foliage in a given species.

The postharvest quality of *Calathea* cut foliage depended both on wilting (loss of freshness) and yellowing. These may be attributed mainly to the loss of turgidity accompanied by chlorophyll degradation (Petridou *et al.*, 2001). The photosynthetic capacity depends on the developmental stage of leaves (Campostrini *et al.*, 2001) and therefore, the carbohydrate levels of foliage at harvest also may have contributed to the differences in vase life exhibited by them.

Generally, younger developing leaves undergo rapid senescence due to high metabolic rates (Smith *et al.*, 1995). A similar behaviour may have resulted in a relatively shorter vase life of the first fully expanded leaves of *Calathea*. However, in *C. zebrina*, the first fully expanded leaves exhibited longer vase life. As indicated by the increase of chlorophyll content during vase life, it may be that the younger leaves in *C. zebrina* continued photosynthesis more efficiently than the rest of the leaves during vase life experiment (Reid *et al.*, 2002). However, to confirm this, a dry weight analysis of leaves would be necessary.

In all three species tested, older leaves contained higher amounts of chlorophyll than chronologically younger leaves, at the time of harvest. This agrees with the pattern reported for foliage including ornamental species like *Gazania splendens* (Cevahir *et al.*, 2004). However, the Correlation analysis does not warrant the suitability of the chlorophyll content of leaves as an index for selection of the best harvesting maturity. The reduction of chlorophyll content during vase life may be attributed to accelerated senescence of the harvested leaves where the loss of protein or chlorophyll content is a general indication for ageing process (Smith *et al.*, 1995).

In conclusion, even a slight difference in the maturity of leaves at harvest contributes largely to the postharvest longevity of *Calathea* species tested. The best harvesting maturity was species dependent. Among the maturity stages tested, only the 1st FEL of *C. zebrina* and the 3rd FEL of *C. lietzei* exhibited the minimum vase life (14 days) acceptable for exportation (pers. comm. with local cut foliage exporters). Further testing of the results of this preliminary study under simulated air-transportation conditions followed by vase life experiments would be useful for determination of the suitability of the above *Calathea* species for exportation.

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REFERENCES

- Campostrini, E., Yamanishi, O.K. and Martinez, C.A. (2001). Leaf gas exchange characteristics of four papaya genotypes during different stages of development. *Revista Brasileira de Fruticultura* **23** (3): 522–525.
- Cevahir, G., Yentur, S., Yazgan, M., Unal, M. and Yilmazer, N. (2004). Peroxidase activity in relation to anthocyanin and chlorophyll content in juvenile and adult leaves of “Mini-star”, *Gazania splendens*. *Pakistan Journal of Botany* **36** (3): 603-609.
- Dole, J. M. and Wikins, H.F. (1999). *Floriculture principles and species*. Prentice Hall, New Jersey Pp.123-137.
- Petridou, M., Voyiatzi, C. and Voyiatzi, D. (2001). Methanol, ethanol and other compounds retard leaf senescence and improve the vase life and quality of cut chrysanthemum flowers. *Postharvest Biology and Technology* **23**: 79-83.
- Reid, M.S., Wollenweber, B. and Serek, M. (2002). Carbon balance and ethylene in the postharvest life of flowering *Hibiscus*. *Postharvest Biology and Technology* **25**: 227-233.
- Smith, B.N., Lytle, C.M. and Hansen, L.D. (1995). Predicting plant growth rates from dark respiration rates: an experimental approach. Proceedings of the Wildland Shrub and Arid Land Restoration Symposium, Las Vegas, NV, Pp.243-245.
- Wills, R., McGlasson, B., Graham, D. and Joyce, D. (1998). *Postharvest: An introduction to the physiology and handling of fruit, vegetables and ornamentals*. UNSW Press, Australia 1-262.