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Effect of Storage Duration and Temperature on Cut Anthurium Flowers

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Abstract. **The optimum storage temperature for flowers of the 'Kaumana', 'Nitta', and 'Ozaki' cultivars of anthurium (*Anthurium andraeanum* Andre) was between 14° and 17°C. A $AgNO_3$ pulse (4 mM, 40 min) given immediately after harvest increased postharvest life of stored flowers but had no effect on flowers that were placed immediately in the vase. Maximum postharvest life was achieved with Ag^+ treated flowers packed for 3 days. It was possible to store packed, untreated flowers for 9 days and still have 2 weeks of postharvest life before spadix browning, spathe blueing, or loss of spathe gloss became objectionable.**

Senescence of anthurium flowers is caused by plugging of the stem vascular tissue (6). Senescence is accompanied by many visible changes, including loss of spathe gloss, spadix necrosis, spathe blueing, stem collapse, and abscission of the spathe and spadix from the stem (4). It has been shown that waxing the spathe (6) or treating the stem with $AgNO_3$ (5) will extend the postharvest life of anthurium flowers. During shipping, anthurium flowers are stored for variable times under a range of temperature regimes. Commercial air freight from Hawaii to mainland destinations takes about 3 days, including packing time. The study reported here was designed to examine the effects of temperature and storage duration on the postharvest quality of anthurium flowers.

Anthurium flowers were obtained from commercial nurseries on the island of Hawaii. Flowers were harvested in the morning and received at the laboratory that afternoon. Two centimeters of flower stem was removed before treatment. Treatments were applied to undamaged flowers that were at least three-fourths mature (4). Flower condition and life was evaluated daily. Parameters evaluated were spadix senescence (necrosis) ranked on a 1 to 5 scale (none to extensive), spathe blueing on a 1 to 4 scale (0% to 100% blueing), and spathe condition on a 1 to 4 scale (full gloss to no gloss and wilting). Flowers were discarded if they were rated at 4 for spadix senescence, 3 for spathe color, or 4 for spathe condition. Ten or 12 replicate flowers were used for each treatment. Vase life was evaluated at 22°C, 70–80% RH, and air movement of 1.2 $m \cdot s^{-1}$ in a room receiving both indirect sunlight and fluorescent light ($\approx$10 $W \cdot m^{-2}$) for 12 hr/day.

When required, stems were pulsed for 40 min in 4 mM $AgNO_3$ at 22°C. After Ag^+ treatment, the stems were rinsed with deionized water (DI), then held in DI water until packing. In the simulated shipping tests, flowers were packed 15 hr after treatment using moistened, shredded newspaper in plastic-lined cardboard boxes. The packed boxes were held at different temperatures for various lengths of time. Upon unpacking, 2 cm of stem was removed and flowers were placed immediately in a 2-liter conical flask filled with DI water. The water was replenished every 2 to 3 days. All experiments were repeated at least twice. A quadratic response surface model was fitted by least-squares regression (SAS Institute, Cary, N.C.). This procedure determined the critical values to optimize the response with respect to either length of storage or temperature.

The postharvest life of untreated packed flowers fell during the first 3 days of storage but subsequently increased (Fig. 1). The calculated minimum occurred at 4.3 days. Flowers stored for 9 days had nearly the same postharvest life as nonpacked flowers. It is possible to store packed, untreated flowers

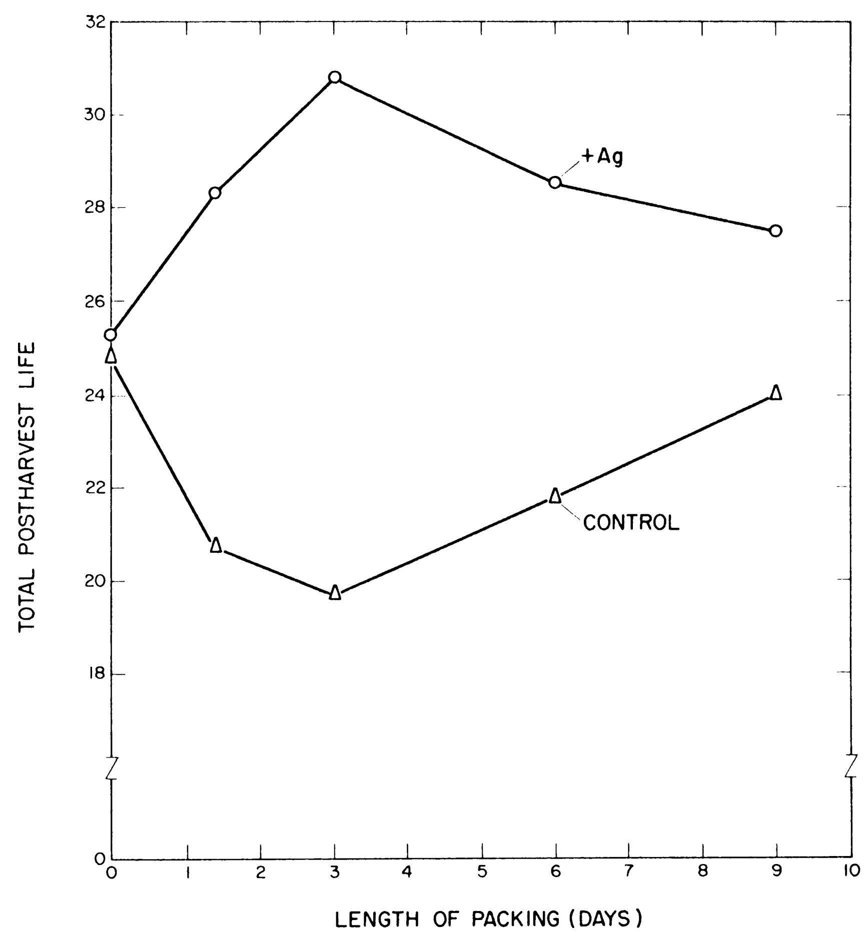

Fig. 1. The effect of length of packing on total postharvest life of 'Ozaki' flowers treated within 9 hr of harvest with a 4mM $AgNO_3$, 40-min pulse vs. untreated controls. Flowers at harvest had 81% open florets. The optimum response equation for the treatments was: Control vase life (days) = 23.94 − (1.79 × storage period) + (0.207 × storage period^2); r^2 = 0.43. Silver vase life (days) = 26.69 + (0.69 × storage period) − (0.084 × storage period^2); r^2 = 0.36.

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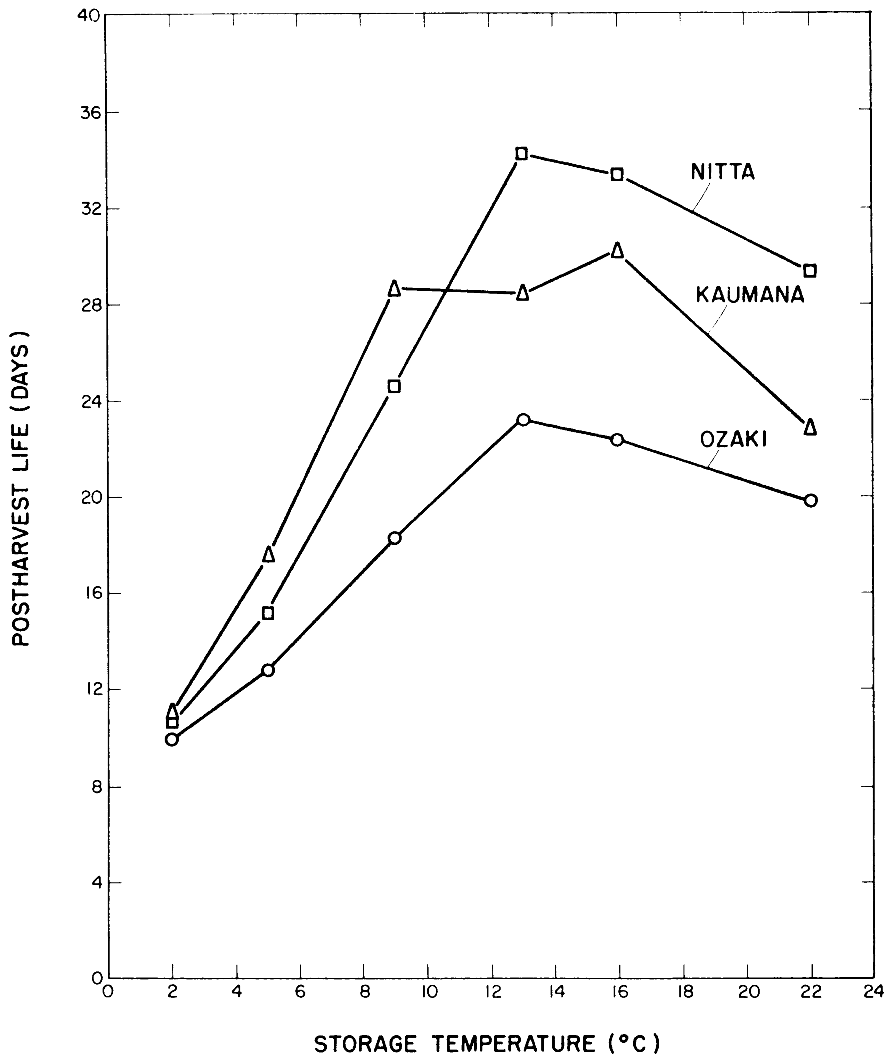

Fig. 2. Relationship between postharvest life including storage for 9 days at different temperatures for three anthurium cultivars not pulsed with $AgNO_3$ and temperature during packing period. At packing, the 'Ozaki' flowers were 87.4% mature, 'Nitta' 78.3%, and 'Kaumana' 84.2%. The optimum response equation for the cultivars was: 'Ozaki' vase life (days) = 5.1 + (2.13 × temperature) − (0.07 × temperature²); r^2 = 0.84. 'Nitta' vase life (days) = 2.0 + (3.72 × temperature) − (0.11 × temperature²); r^2 = 0.84. 'Kaumana' vase life (days) = 3.8 + (3.68 × temperature) − (0.13 × temperature²). r^2 = 0.78. All regressions were statistically significant.

for 9 days, the minimum time for surface-shipping to the West Coast, and still have at least 2 weeks of usable vase life (Fig. 1). Other tests indicated that storage in moistened shredded newspaper for 2 weeks at 22°C would still leave 4 days of useful retailing life. The cause of this unusual storage behavior is not yet explained.

Silver nitrate pulsing (4 mM, 40 min) had no effect on the postharvest life of flowers held continuously in DI water. In striking contrast to untreated flowers, the postharvest life of stored Ag^+-treated flowers was always higher than that of those held continuously in DI water. Maximum postharvest life was achieved with Ag^+-treated flowers packed for 3 days. The response surface model fitted by least square indicated the optimum storage period to be 4.1 days. One possible explanation for this unique response to dry storage and Ag^+ treatment is that a wound reaction, perhaps mediated by enhanced ethylene production, results in plugging of the vascular system in flowers stored for a few days and then placed in water. The low solubility of ethylene in water might exacerbate this effect (3). Prolonged life of Ag^+-treated flowers stored for several days might affect the time required for Ag^+ to diffuse to the tissue responsible for the vascular plugging.

An optimum storage temperature of about 13°C has been reported for the anthurium cultivar Kaumana (2). There were differences among the cultivar responses to 9 days of storage at various temperatures (Fig. 2). The optimum storage temperatures were 14° for 'Kaumana', 16° for 'Ozaki', and 17° for 'Nitta' anthuriums, suggesting a usable storage temperature range of from 14° to 17°. Other workers suggested a 15.5° optimum (7), determined on the basis of a limited number of temperatures (1.6°, 8.3°, and 15.5°) and short periods of treatment (<3 hr). For all cultivars, storage at the optimum gave 3 to 4 days increase in total postharvest life compared to storage at room temperature.

The postharvest life of flowers stored below the optimum storage temperature was reduced markedly by chilling injury. The injury symptoms were premature blueing of the spathe and necrosis of the spadix. All cultivars showed these symptoms after storage for 9 days at 2°C. Storage of flowers for 1 hr at 2° is regarded as deleterious (7). Slight cultivar differences in chilling symptoms were noted. 'Kaumana' was less sensitive to chilling temperatures (Fig. 2) than the other two cultivars. Storage of 'Nitta' flowers for 9 days at 12° gave the longest total postharvest life. These results agree with those of Kamemoto (2).

The above results suggest that surface-shipping of cut anthurium flowers to the mainland United States might be considered. Additional extension of postharvest life might be possible it low oxygen storage (2%) were also used (1).

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