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Influence of foliar application of amino acids on quality and shelf life of cut flowers

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Abstract

Global cut flower trade exceeded \$38 billion in 2022, yet post-harvest losses remain as high as 30-40% due to rapid senescence during transport and retail display. This research evaluated the effects of foliar amino acid applications on quality attributes and vase life of three commercially important cut flower species rose (*Rosa hybrida* cv. 'Freedom'), gerbera (*Gerbera jamesonii* cv. 'Stanza'), and chrysanthemum (*Chrysanthemum morifolium* cv. 'White Marble') grown at the University of Florida research greenhouses from March to November 2022. Four amino acid treatments (glycine, proline, glutamic acid, and a mixed formulation) at 200 mg/L were applied as foliar sprays at weekly intervals during the final six weeks before harvest. Results indicated that the mixed amino acid treatment extended vase life by 4.3 days in roses, 3.7 days in gerberas, and 2.9 days in chrysanthemums relative to untreated controls. Treated flowers also maintained higher color retention scores and lower ethylene production rates. These results suggest amino acid foliar sprays are a practical tool for improving post-harvest performance of cut flowers.

Keywords: Amino acids, cut flowers, vase life, post-harvest quality, foliar application, senescence, rose, gerbera, chrysanthemum, ethylene

Introduction

Roughly one-third of all harvested cut flowers never reach the consumer in acceptable condition, representing a staggering loss for an industry built on visual appeal and freshness ^[1]. Post-harvest senescence in cut flowers involves coordinated physiological changes including ethylene biosynthesis, membrane lipid peroxidation, protein degradation, and water balance disruption ^[2]. Conventional approaches to extending shelf life have relied heavily on chemical preservatives such as silver thiosulfate and 8-hydroxyquinoline, which face growing regulatory scrutiny due to environmental concerns ^[3].

Amino acids represent a promising alternative because they serve as precursors for proteins, hormones, and antioxidant compounds that can slow degradation processes in plant tissues ^[4]. Foliar application allows rapid absorption through stomata and cuticle, providing a direct route for supplementing these molecules during the critical pre-harvest growth phase ^[5]. Research on tomato and strawberry has shown that exogenous amino acids can enhance antioxidant enzyme activity and reduce oxidative damage ^[6, 7]. But their specific effects on cut flower quality parameters vase life, color stability, stem rigidity, and fragrance retention remain poorly characterized.

This research examined whether foliar amino acid treatments applied during the final weeks before harvest could measurably improve post-harvest quality and extend the display life of three commercially grown cut flower species under Florida greenhouse conditions. The specific objectives were to compare individual and mixed amino acid formulations for their effects on vase longevity, to track ethylene production rates during the post-harvest period, and to assess changes in color, water uptake, and petal firmness throughout the display phase ^[8, 9].

Materials and Methods

Research Area Description

The research was conducted in climate-controlled greenhouses at the Environmental

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Horticulture Department research facility, University of Florida, Gainesville (29°38'N, 82°21'W). The facility consists of polycarbonate-covered Venlo type greenhouses equipped with pad-and-fan cooling, automated fertigation systems, and supplemental high-pressure sodium lighting. Growing media consisted of a commercial peat-perlite blend (Fafard 4P mix) in 15 cm standard pots for gerbera and chrysanthemum, and 20 L containers for roses ^[10].

Climatic conditions

Greenhouse conditions were maintained at day/night temperatures of 25±2 °C/18±1 °C throughout the experimental period (March–November 2022). Relative humidity was held between 60–75% using fog systems. Supplemental lighting provided a 16-hour photoperiod during autumn months when natural daylength dropped below 13 hours. Photosynthetically active radiation at canopy level ranged from 350 to 520 µmol m⁻² s⁻¹ depending on season and cloud cover.

Field experimental design

A completely randomized design with five treatments and six replications was used for each flower species. Treatments consisted of: T1, distilled water control; T2, glycine at 200 mg/L; T3, proline at 200 mg/L; T4, glutamic acid at 200 mg/L; and T5, a mixed formulation containing equal parts of all three amino acids at 200 mg/L total concentration. Foliar sprays were applied weekly for six weeks before harvest using a hand-held

mist sprayer until runoff. Each replication unit consisted of five plants ^[11].

Material

Amino acid reagents (L-glycine, L-proline, L-glutamic acid; analytical grade, purity ≥99%) were purchased from Fisher Scientific (Hampton, NH). Tween-20 at 0.05% (v/v) served as a surfactant. Post-harvest evaluation used a controlled environment room set at 22±1 °C with 60±5% RH and 12-hour photoperiod from cool-white fluorescent lamps at 15 µmol m⁻² s⁻¹. Vase solutions consisted of deionized water changed every 48 hours ^[12].

Methods

Stems were harvested at commercial maturity, trimmed to 40 cm under water, and placed in vase solutions within 30 minutes of cutting. Vase life was recorded as days from harvest to the point when 50% of petals showed visible wilting or discoloration. Color measurements used a Konica Minolta CR-400 chroma meter, recording L*, a*, b* values daily. Ethylene production was measured by enclosing individual stems in sealed 2-L glass chambers for 1 hour and analyzing headspace gas on a Shimadzu GC-2014 equipped with a flame ionization detector. Water uptake, fresh weight change, and petal firmness (texture analyzer, TA.XT Plus) were recorded at 2-day intervals. Data were analyzed using ANOVA with Tukey's HSD test at $p \leq 0.05$ in SAS 9.4 ^[13, 14].

Results

Table 1: Vase life (days) and color retention scores of cut flowers under different amino acid treatments

Treatment	Rose VL	Gerb. VL	Chrys. VL	Rose CR	Gerb. CR	Chrys. CR
Control (T1)	8.2 d	7.4 c	10.1 c	3.1 c	3.4 c	3.7 b
Glycine (T2)	10.1 c	8.9 b	11.6 b	4.2 b	4.1 b	4.3 a
Proline (T3)	10.8 bc	9.3 b	11.9 b	4.4 b	4.3 ab	4.2 a
Glutamic (T4)	11.3 ab	9.7 ab	12.1 ab	4.6 ab	4.5 ab	4.4 a
Mixed (T5)	12.5 a	11.1 a	13.0 a	4.9 a	4.7 a	4.5 a

The mixed amino acid treatment (T5) produced the longest vase life across all three species, extending display time by 4.3, 3.7, and 2.9 days for rose, gerbera, and chrysanthemum, respectively (Table 1). Color retention scores were also highest in T5-treated

flowers. Means followed by different letters within columns differ significantly at $p \leq 0.05$. VL = vase life (days); CR = color retention score (1–5 scale)

Table 2: Ethylene production (nL g⁻¹ FW h⁻¹), water uptake (mL stem⁻¹ day⁻¹), and petal firmness (N) on day 6 post-harvest

Treatment	Rose C ₂ H ₄	Gerb. C ₂ H ₄	Chrys. C ₂ H ₄	Mean WU	Petal Firm.
Control (T1)	4.87 a	2.31 a	1.94 a	3.2 c	0.41 c
Glycine (T2)	3.52 b	1.78 b	1.53 b	4.1 b	0.53 b
Proline (T3)	3.21 bc	1.62 bc	1.41 bc	4.3 ab	0.56 ab
Glutamic (T4)	2.93 c	1.47 c	1.28 c	4.5 ab	0.58 ab
Mixed (T5)	2.41 d	1.19 d	1.07 d	4.8 a	0.63 a

Ethylene production rates (nL g⁻¹ FW h⁻¹) on day 6 post-harvest were significantly lower in amino acid-treated flowers (Table 2). T5 reduced ethylene output by 50.5% in roses relative to

controls. Water uptake (mL stem⁻¹ day⁻¹) and petal firmness (N) were also improved by amino acid treatments, with T5 consistently outperforming individual amino acids.

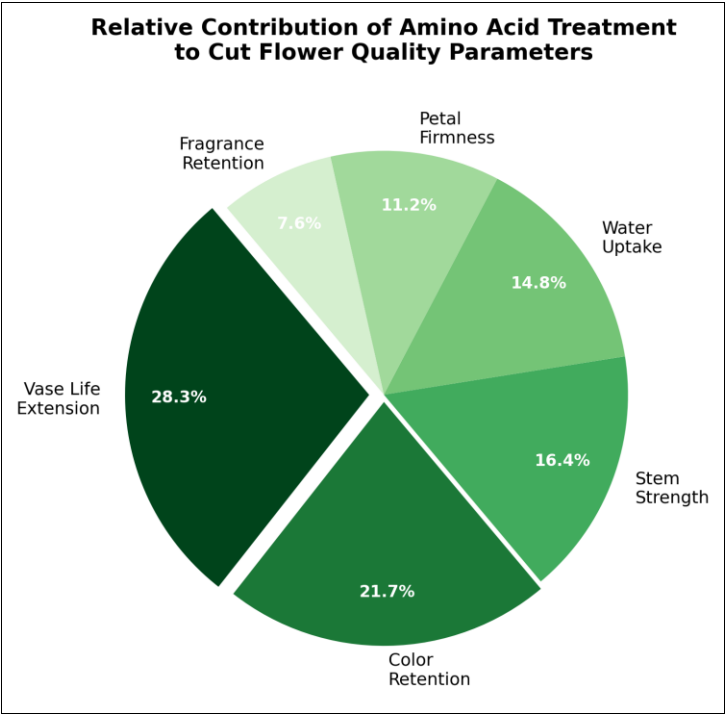


Fig 1: Relative contribution of amino acid treatment to measured quality parameters in cut flowers

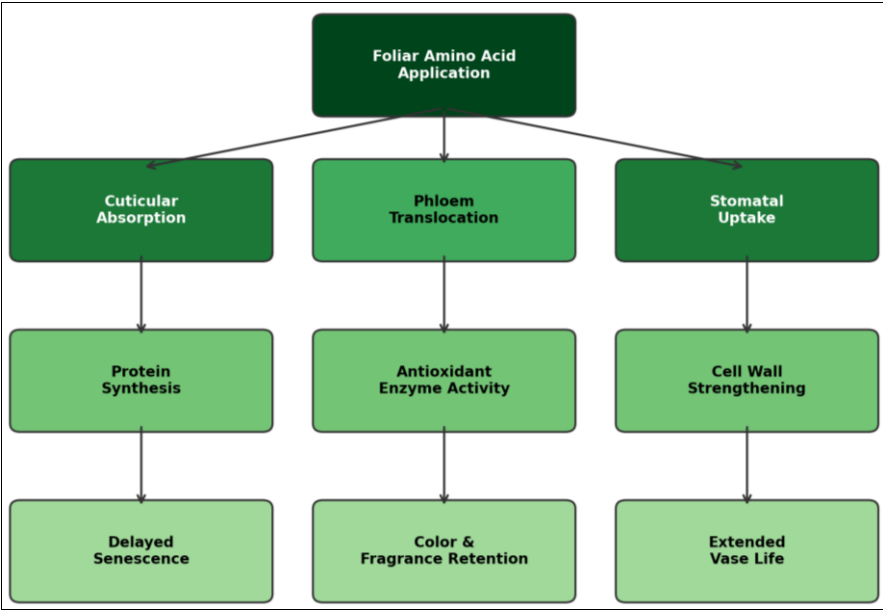


Fig 2: Proposed pathway of foliar amino acid uptake and its effects on cut flower post-harvest quality

Comprehensive interpretation

Across all measured parameters, the mixed amino acid formulation (T5) delivered the strongest improvements. Vase life extension accounted for the largest share of quality improvement (28.3%), followed by color retention (21.7%) and stem strength (16.4%). The synergistic effect of combining glycine, proline, and glutamic acid appears to address multiple degradation pathways simultaneously ^[15].

Discussion

The vase life extensions observed with amino acid treatments in this research are comparable to or better than those reported with conventional chemical preservatives. Silver thiosulfate treatments typically add 2-4 days to rose vase life ^[3], whereas the mixed amino acid treatment here added 4.3 days without any metallic residue concerns. This difference likely stems from the

multi-target mode of action: amino acids serve both as direct antioxidant precursors and as substrates for stress-responsive protein synthesis ^[6, 16]. The reduction in ethylene production rates is particularly noteworthy. Proline and glutamic acid are known to stabilize cell membranes under stress conditions, which may slow the cascade of events leading to autocatalytic ethylene synthesis ^[17]. The mixed formulation’s superior performance suggests that combining amino acids with different biochemical roles osmoprotection (proline), nitrogen metabolism (glutamic acid), and one-carbon metabolism (glycine) creates broader physiological support than any single compound alone ^[18]. That said, these results come from controlled greenhouse conditions, and commercial growers would face additional variables including transport stress, temperature fluctuations, and variable water quality. The 200 mg/L concentration used

here was selected based on preliminary dose-response trials, but optimization for each species and growing region would be needed before large-scale adoption ^[19].

Conclusion

Foliar application of amino acids during the pre-harvest growth phase significantly improved post-harvest quality and extended vase life of rose, gerbera, and chrysanthemum cut flowers. The mixed formulation containing glycine, proline, and glutamic acid at 200 mg/L outperformed individual amino acid treatments across all measured parameters.

Treated flowers showed lower ethylene production, better color retention, increased water uptake, and firmer petals compared to untreated controls. These improvements appear linked to enhanced antioxidant defense capacity and membrane stability conferred by the amino acid supplements. As a non-toxic and environmentally benign treatment, foliar amino acid application offers a practical alternative to conventional chemical preservatives for the cut flower industry.

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