Response of Roses and Gladiolus Flower to Some Storage Treatments After Harvesting.

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Abstract

Given the significance of cut flowers in social and religious life, as well as their extensive use in most formal gatherings, this study aimed to investigate the effect of storage methods and the use of certain preservatives on extending the vase life of two types of flowers (roses and gladiolus). The results indicated the superiority of refrigerated storage (S2) combined with the addition of chitosan (A3) in prolonging on the experiment conducted in the care and storage laboratory of department of Horticulture and Landscape Gardening to the vase life of rose flowers, as demonstrated in the experiment conducted on shrub roses. The role of chitosan in extending vase life is attributed to its ability to enhance carbohydrate conversion, which leads to an increase in fresh weight. Additionally, chitosan contributes to the biosynthesis of pectin in cell walls and protects plant cell walls from water loss. This, in turn, results in increased water uptake and reduced water loss. In the second experiment (gladiolus flowers), the dry storage treatment combined with dipping the floral stem bases in salicylic acid showed superiority. This may be due to its role in protecting cell membranes from oxidative stress or its involvement in protein synthesis, which facilitates the transport of these proteins through the phloem to the flowers. This process helps prolong their vase life and prevents deterioration. Furthermore, salicylic acid inhibits ethylene production, which enhances flower longevity and prevents degradation.

Keywords: rose, gladiolus, chitosan, salicylic acid, ascorbic acid

Introduction

The cultivation of flowers has become one of the most common strategies in the horticultural sector in recent years. The international trade of cut flowers has expanded and is expected to grow further with promotion and application across various industries. This growth is driven by the remarkable beauty of cut flowers and their popularity among people worldwide. However, the short vase life of cut flowers poses a challenge in maintaining their appearance and quality [11.[

The postharvest period of cut flowers is critical in determining their market value [8]. Moreover, it is challenging to market cut flowers with a short vase life without compromising their quality. In this context, maintaining the quality of cut flowers and extending their vase life is of utmost importance. One of the key factors influencing the vase life of cut flowers is water stress [3.[

Cut flowers are among the key commercial products in the flower industry. According to Solgi et al. [20], cut flowers are among the most demanded items by consumers worldwide due to their beauty, as well as their appearance, fragrance, and diverse floral forms. Gun and Ozturk [10] noted that the interest in ornamental flowers is increasing day by day, driven by sectorial

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developments and a rise in consumers' purchasing power. One of the major factors contributing to the rapid deterioration of flowers is the proliferation of microorganisms in vase water. These organisms cause vascular bundle blockage, water loss, and increased respiration in flowers, all of which result in a shorter vase life. The end of vase life in cut flowers is often explained as floral wilting caused by water loss in the cells [22.[

The rose, often referred to as the "queen of flowers" [Rosa hybrid], belongs to the Rosaceae family. It is one of the most globally recognized cut flowers due to its numerous features, including the beauty and variety of its colors and forms [5], ranging from yellow, white, pink, to red. It is also known for its long floral stems and, in some cultivars, a fragrant aroma. Additionally, roses have a relatively long vase life, lasting up to 12 days. They are widely used in various social, formal, and religious occasions [17.[

Gladiolus (Gladiolus hybrids) belongs to the Iridaceae family and is well-suited for commercial cutting. Its inflorescences are widely used in floral arrangements for various occasions, primarily due to their long vase life, which can often extend up to two weeks. Gladiolus is admired for the beauty of its inflorescences, the diversity of its cultivars, and the variety of its flower shapes and colors, including red, yellow, white, and bi-colored combinations. Additionally, some cultivars possess a distinctive fragrant aroma [15]. Salicylic acid [SA] is a Salicylic acid [SA] is a natural growth regulator that plays a significant role in enhancing plant resistance to both biotic and abiotic stress [1]. Salicylic acid has the ability to lower the pH of water and inhibit bacterial growth in vase solutions [6]. Numerous studies have demonstrated that salicylic acid inhibits the action of ethylene, thereby prolonging the vase life of many types of cut flowers [21.[

Chitosan is a natural biopolymer and one of the most abundant biostimulants, ranking as the second most abundant polysaccharide on Earth [23]. It is derived from chitin through deacetylation of the outer shells of crustaceans such as crabs and shrimp, as well as the exoskeletons of insects and fungal cell walls. Chitosan serves as a primary structural component of these cells and exoskeletons [2.[

Ascorbic acid [Vitamin C] is an essential compound for improving plant growth and extending vase life. Vitamin C is associated with various biological functions, including acting as a cofactor for enzymes, an antioxidant, and an electron transporter in the plasma membrane and plastids [8 [

Given the importance of cut flowers in social and religious life, as well as their extensive use in most formal gatherings, we conducted this study to investigate the effect of storage methods and the use of certain preservatives on extending the vase life of two types of flowers (roses and gladiolus.(

Materials and Methods

The experiment was conducted in the Care and Storage Laboratory of the Department of Horticulture and Landscape Engineering, College of Agricultural Engineering Sciences, during the 2024 academic year. The study aimed to evaluate the response of rose and gladiolus flowers to certain postharvest storage treatments and the effect of preservatives on extending their vase life.

The flowers were obtained from flower shops in Baghdad. For roses (Sunshine Rose cultivar) with bright yellow color, flowers were collected at the stage where three petals

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had opened. For gladiolus (Friendship cultivar), flowers were collected at the stage of the first basal floret opening. The flowers were sorted and graded based on flower size, stem length, and floral stalk. The lower leaves were removed from the stems, leaving the top four leaves intact (for roses). The stems were recut to a length of 25 cm for roses and 35 cm for gladiolus floral spikes. The lower part of the stems was cut using a sharp knife to prevent tissue tearing. The initial weights of the flowers were recorded before storage. The flowers were placed in containers half-filled with 500 mL of distilled water containing preservative solutions. The flowers were stored in refrigerators set at a temperature of 5 ± 2°C and a relative humidity of 65 ± 5%. Humidity and temperature were monitored using a hygrometer installed in the storage laboratory.

Treatments: First Factor: Storage Methods

.1 No Storage (Control) (S0(

For comparison, flowers were placed in 500 mL containers of distilled water and kept at room temperature (laboratory conditions) to determine their vase life.

.2 Dry Storage(S1(

Flowers were wrapped in transparent cellophane, with perforations made in the wrapping. Three flowers were used per treatment, placed horizontally to prevent breakage. Preservatives, as previously mentioned, were applied.

.3 Wet Storage: (S2(

Flowers were stored in clean and sterilized refrigerators in the Care and Storage Laboratory of the Department of Horticulture and Landscape Engineering. The flowers were placed in containers containing 500 mL of distilled water after standardizing the stem and floral stalk lengths. The flowers were then stored in refrigerators at a temperature of 5 ± 2°C and a relative humidity of 65 ± 5%.

: Preservative Treatments

For dry storage, the bases of the flowers were dipped in preservative solutions. For wet storage, preservative solutions were mixed with the water in the containers. The preservative treatments I included:

.1 Control Treatment: Distilled water. (A0) [13.[

.2Ascorbic Acid (A1(

At a concentration of 150 mg L^{-1} [7.[

.3 Salicylic Acid (SA (

.4At a concentration of 5 mg L^{-1} [18.[

Chitosan:(A3 (

At a concentration of 1.5%.

The experiment was designed as a factorial experiment using a Randomized Complete Block Design (RCBD) with two factors:

Factor 1: Storage methods (three levels.(

Factor 2: Preservative treatments (four types.(

Each treatment combination was replicated three times (3×4×3), with three flowers included in each experimental unit. Measurements were recorded over a storage period of 5 days.

Studied Indicators

.1 Fresh Weight After Storage (g:(

The fresh weight of flowers was measured after the storage period.

.2 Vase Life (days:(

The vase life was calculated as the number of days the flowers (three floral stems) remained in the containers until they lost their decorative value [19.[

.3 Water Absorption (g floral $stem^{-1}$ day^{-1}:(

Water absorption was calculated by measuring the weight of the vase solution on the first day and then every two days until wilting. The formula by He et al. [12] was used:

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Water Absorbed=Weight of Vase Solution on Previous Day−Weight of Vase Solution

.4 Water Loss (g floral stem^{-1} day^{-1}:(

Water loss was determined by weighing the floral stem along with the vase solution on the first day and every two days until wilting. The average was calculated using the formula by He et al. [12:[

Water Lost=Weight of Vase Solution with Floral Stem on Previous Day−Weight of Vase Solution with Floral Stem

.5 Water Balance (g floral stem^{-1} day^{-1}:(

Water balance was calculated using the equation provided by He et al. [12[

.6 Flower Diameter (cm:(

The diameter of the flowers was measured after storage.

.7 Carotenoid Content After Storage (mg per 100 g^{-1} fresh weight:(

Carotenoid content was determined in the flowers after storage.

.8 Dry Weight (g:(

The dry weight of flowers was recorded.

.9 Percentage of Carbohydrates (mg g^{-1} fresh weight:(

The carbohydrate content in the flowers was calculated as a percentage of fresh weight.

Results and Discussion

.1Rose Flowers

The results indicate a significant effect of storage methods on the fresh weight of shrub roses (Table 1). The wet storage method (S2) demonstrated a clear superiority, achieving the highest fresh weight of 62.82 g compared to the dry storage method, which resulted in the lowest fresh weight of 38.42 g. Regarding the effect of preservative solutions on the fresh weight of shrub roses, the treatment with chitosan (A3) significantly increased the fresh weight to 57.91 g, compared to the flowers treated with distilled water (control), which had a fresh weight of 45.34 g. The interaction between storage methods and preservative solutions showed a notable impact. The combination of wet storage and chitosan treatment (S2A3) recorded the highest fresh weight of 69.60 g, whereas the control treatment with no storage and no preservatives (S0A0) resulted in the lowest fresh weight of 42.71 g.

The results demonstrate a significant impact of storage methods and preservative treatments on the vase life of rose flowers. The wet storage method (S2) significantly extended the vase life to 12.83 days, compared to the control (8.50 days). Among the preservative treatments, chitosan (A3) showed superior performance, increasing the vase life to 11.88 days compared to the control (9.22 days). The interaction between wet storage and chitosan (S2A3) yielded the longest vase life of 14.33 days, highlighting the synergistic effect of these treatments. In contrast, the shortest vase life of 7.66 days was observed in the control treatment without storage or preservatives. These findings underscore the importance of combining proper storage techniques and effective preservative solutions to maximize the vase life and quality of cut flowers.

The results in table 1 also highlight the effects of storage methods and preservative treatments on the amount of water absorbed and lost by the flowers. Table 1 show that the wet storage method (S2) had a significant impact on increasing both water absorption and water loss, recording values of 4.104g and 3.357 g, respectively. In contrast, the control treatment showed lower values, with water absorption and loss measured at3.232 g and 1.405 g, respectively .

The effect of preservative treatments on water absorption and loss was also significant. The chitosan treatment (A3) demonstrated the highest values for both water absorbed and lost, recording 4.550g and 2.904 g, respectively, compared to the distilled water control treatment, which recorded 3.704g and 1.964 g, respectively.

The interaction between storage methods and preservative treatments had a clear and significant impact on both traits, as shown in Table 1. The combination of wet storage and chitosan (S2A3) achieved the highest values for water absorbed and lost, measuring 5.852g and 3.973 g, respectively. This interaction was not significantly different from the S2A3 treatment. In contrast, the control treatment (S0A0) recorded the lowest values for water absorption (2.650g) and water loss (1.290 g .(

Table (1): Response of Rose flowers to certain postharvest storage treatments. Water absorbed

Treatment		Fresh weight g)	Vase life (days	Water lost(g)	Water bsorbed(g)
S effect					
No storage (S0)		38.42	8.50	**1.405**	**8.500**
Dry storage (S1)		50.93	10.25	**2.456**	**5.261**
Wet storage (S2)		62.82	12.83	**3.357**	**4.104**
LSD		0.966	0.397	**0.0261**	**0.0412**
A effect					
A0 (Dist. Water)		45.34	9.22	**1.694**	**3.704**
A1 (Ascorbic Acid)		47.92	10.22	**2.395**	**4.090**
A2 (Salicylic Acid)		51.83	10.77	**2.812**	**4.452**
A3 (Chitosan)		57.91	11.88	**2.904**	**4.550**
LSD		1.116	0.458	**0.0301**	**0.0544**
A * S effect					
S0	**A0**	**42.71**	**7.66**	**1.290**	**2.650**
	A1	**40.60**	**9.00**	**1.168**	**3.555**
	A2	**36.48**	**11.00**	**1.817**	**3.499**
	A3	**34.18**	**8.00**	**1.887**	**3.225**
Dry storage S1	**A0**	**61.42**	**10.00**	**1.613**	**3.606**
	A1	**51.21**	**12.66**	**2.604**	**4.108**
	A2	**46.11**	**8.66**	**2.753**	**4.129**
	A3	**44.98**	**10.33**	**2.854**	**4.573**
Wet storage (S2)	**A0**	**56.86**	**13.33**	**2.177**	**4.606**
	A1	**63.68**	**9.66**	**3.413**	**4.857**
	A2	**61.16**	**11.66**	**3.865**	**5.727**
	A3	**69.60**	**14.33**	**3.973**	**5.852**
LSD		**1.933**	**0.794**	**0.1081**	**0.0768**

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The results in Table (2) illustrate the effects of the storage methods used in the study (no storage, dry storage, and wet storage) on flower diameter, carotenoid content, and carbohydrate content of the petals after five days of storage. The wet storage method outperformed the other studied methods for the above-mentioned traits, achieving a flower diameter of 9.343 cm, a carotenoid content of 9.58 mg g^{-1} fresh weight, and a carbohydrate content of 20.508 mg g^{-1} fresh weight. In contrast, the control treatment (no storage) recorded significantly lower values, with a flower diameter of 6.240 cm, a carotenoid content of 6.64 mg g^{-1} fresh weight, and a carbohydrate content of 18.533 mg g^{-1} fresh weight, respectively.

Regarding the effect of preservative solutions on the studied indicators in the same table, the treatment with A3 (chitosan preservative solution) showed a significant superiority in increasing flower diameter, carotenoid content, and carbohydrate content in the petals. The values recorded for this treatment were 8.490 cm, 8.87 mg g^{-1} fresh weight, and 19.992 mg g^{-1} fresh weight, respectively. In contrast, the control treatment (A0) yielded lower values, with a flower diameter of 7.016 cm, a carotenoid content of 7.22 mg g^{-1} fresh weight, and a carbohydrate content of 18.872 mg g^{-1} fresh weight.

The interaction between storage methods and preservative treatments had a clear and significant impact on the studied traits, as shown in the table. The combination S2A3 (wet storage with chitosan) achieved the highest values for all traits, with a flower diameter of 10.650 cm, carotenoid content of 10.36 mg g^{-1} fresh weight, and carbohydrate content of 21.307 mg g^{-1} fresh weight. In contrast, the control treatment (S0A0) resulted in the lowest values, with a flower diameter of 5.413 cm, carotenoid content of 5.03 mg g^{-1} fresh weight, and carbohydrate content of 18.173 mg g^{-1} fresh weight.

Table 2. Response of Rose flowers to certain postharvest storage treatments.

Treatment		Flower diameter during storage (cm)	Petal carotenoid content after storage (mg g^{-1} fresh weight)	Total carbohydrate content in petals (mg g^{-1} fresh weight)
S effect				
No storage (S0)		**6.240**	**6.64**	**18.533**
Dry storage (S1)		**7.417**	**8.19**	**19.352**
Wet storage (S2)		**9.343**	**9.58**	**20.508**
LSD		**0.1202**	**0.616**	**0.2188**
A effect				
A0 (Dist. Water)		**7.016**	**7.22**	**18.872**
A1 (Ascorbic Acid)		**7.417**	**8.06**	**19.281**
A2 (Salicylic Acid)		**7.743**	**8.40**	**19.713**
A3 (Chitosan)		**8.490**	**8.87**	**19.992**
LSD		**0.1387**	**0.711**	**0.2526**
A * S effect				
S0	**A0**	**5.413**	**5.03**	**18.173**
	A1	**6.140**	**6.81**	**18.447**
	A2	**6.657**	**7.23**	**18.677**
	A3	**6.750**	**7.50**	**18.837**

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Dry storage S1	**A0**	**6.883**	**7.57**	**18.777**
	A1	**7.190**	**8.08**	**19.117**
	A2	**7.523**	**8.73**	**19.683**
	A3	**8.070**	**8.36**	**19.833**
Wet storage (S2)	**A0**	**8.750**	**9.05**	**19.667**
	A1	**8.920**	**9.30**	**20.280**
	A2	**9.050**	**9.62**	**20.780**
	A3	**10.650**	**10.36**	**21.307**
LSD		**0.2403**	**0.711**	**0.4375**

Second: Gladiolus Flowers

The results in Table (3) indicate significant differences in the effect of storage methods on the fresh weight of gladiolus flowers. The dry storage method showed a significant advantage over other storage methods (no storage and wet storage), achieving the highest fresh weight of 97.45 g, compared to the flowers that were not stored, which recorded the lowest fresh weight of 78.35 g. Regarding the effect of preservative treatments on the fresh weight of gladiolus flowers, the A2 treatment (salicylic acid) outperformed other preservatives, resulting in a fresh weight of 92.42 g, compared to the control treatment, which recorded the lowest fresh weight of 85.39 g.

The interaction between the studied factors had a clear effect on increasing the fresh weight of gladiolus flowers. The combination of S1A2 (dry storage with salicylic acid) showed the highest fresh weight of 98.45 g, significantly outperforming the control treatment, which recorded 73.32 g. The results in Table (3) show that the storage methods used significantly impacted the vase life of gladiolus flowers. The dry storage method (S2) achieved the longest vase life, lasting 10.75 days, compared to the control treatment (no storage), which recorded a vase life of 6.83 days. The results also highlight the significant effect of preservative treatments on prolonging the vase life of gladiolus flowers. The A2 treatment (salicylic acid) resulted in a vase life of 9.44 days, compared to the control treatment, which recorded 7.66 days. Furthermore, the interaction between storage methods and preservative treatments had a significant effect on extending the vase life of gladiolus flowers. The combination of S1A2 (dry storage with salicylic acid) achieved the longest vase life of 12.00 days, compared to the control treatment (S0A0), which recorded the shortest vase life of 6.33 days. The amount of water absorbed by cut gladiolus flowers and its relationship with the storage method shows that dry storage (S1) significantly outperformed other storage methods. The dry storage treatment recorded the highest values for water absorbed and lost, at 7.629 g and 7.358 g, respectively.

Regarding the effect of preservative treatments, the A2 treatment (salicylic acid) showed superiority in increasing both water absorption and loss, with values of 6.769 g and 6.625 g, respectively, compared to the control treatment, which recorded 5.293 g and 5.456 g, respectively.

Table (3) also highlights a significant interaction between the studied factors on water absorption and loss. The combination S1A2 (dry storage with salicylic acid) recorded the highest values, with 8.875 g of water absorbed and 8.576 g of water lost. In contrast, the control treatment (S0A0) resulted in the lowest values, with 3.424 g of water absorbed and 4.247 g of water lost.

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Table 3. Response of Gladiolus flowers to certain postharvest storage treatments

Treatment		Fresh weight (g)	Vase life (days)	Water lost (g)	Water
S effect					
No storage (S0)		78.35	6.83	4.027	4.411
Dry storage (S1)		97.45	10.75	7.629	7.358
Wet storage (S2)		88.56	8.00	5.714	5.951
LSD		1.118	0.3715	0.1581	0.1951
A effect					
A0 (Dist. Water)		85.39	7.66	5.293	5.456
A1 (Ascorbic		85.25	8.22	4.964	5.281
A2 (Salicylic		92.41	9.44	6.769	6.625
A3 (Chitosan)		89.43	8.77	6.136	6.265
LSD		1.290	0.4290	0.1581	0.2253
A * S effect					
S0	A0	73.32	6.33	3.424	4.247
	A1	76.66	7.00	3.695	3.985
	A2	80.69	9.66	4.287	4.810
	A3	82.73	6.66	4.703	4.601
Dry storage S1	A0	85.22	7.66	4.700	5.591
	A1	83.49	10.33	5.183	5.644
	A2	98.45	12.00	8.875	8.576
	A3	89.47	9.00	6.728	6.700
Wet storage (S2)	A0	97.63	7.00	7.754	5.871
	A1	95.59	7.33	6.013	6.213
	A2	96.05	9.00	6.247	6.530
	A3	98.12	11.00	7.873	8.115
LSD		2.235	0.7431	0.1826	0.3903

The results indicate significant differences in flower diameter and carbohydrate content in gladiolus flowers (Table 4). The S1 treatment (dry storage) showed superiority in the studied indicators, recording the largest flower diameter and highest carotenoid content after five days of storage, with values of 8.261 cm and 8.079 mg g^{-1} fresh weight, respectively.

For the effect of preservative treatments, the A2 treatment (flowers treated with salicylic acid) significantly enhanced flower diameter and carbohydrate content, recording 7.484 cm and 7.472 mg g^{-1} fresh weight, respectively, compared to the control treatment, which recorded the smallest flower diameter (5.781 cm) and the lowest carotenoid content (5.537 mg g^{-1} fresh weight.(

The interaction between storage method and preservative treatments had a significant pact on the studied indicators. The S1A2 treatment (dry storage with salicylic acid) achieved the largest flower diameter (9.117 cm) and the highest carbohydrate content (9.180 mg g^{-1} fresh weight), compared to the control treatment (S0A0), which recorded the lowest values, with a flower diameter of 4.260 cm and a carbohydrate content of 4.367 mg g^{-1} fresh weight.

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Table 4. Response of Gladiolus flowers to certain postharvest storage treatments

Treatment		Flower diameter during storage (cm)	Total carbohydrate content in petals (mg g^{-1} fresh weight)
S effect			
No storage (S0)		**4.804**	**4.857**
Dry storage (S1)		**8.261**	**8.079**
Wet storage (S2)		**6.713**	**6.753**
LSD		**0.1394**	**0.1926**
A effect			
A0 (Dist. Water)		**5.781**	**5.537**
A1 (Ascorbic Acid)		**6.316**	**6.397**
A2 (Salicylic Acid)		**7.484**	**7.472**
A3 (Chitosan)		**6.790**	**6.847**
LSD		**0.1609**	**0.2224**
A * S effect			
S0	**A0**	**4.260**	**4.367**
	A1	**4.623**	**4.780**
	A2	**4.920**	**4.810**
	A3	**5.413**	**5.470**
Dry storage S1	**A0**	**5.857**	**5.703**
	A1	**6.203**	**6.423**
	A2	**9.117**	**9.180**
	A3	**6.870**	**7.120**
Wet storage (S2)	**A0**	**7.227**	**6.540**
	A1	**8.120**	**7.987**
	A2	**7.923**	**7.767**
	A3	**8.580**	**8.610**
LSD		**0.2787**	**0.3852**

Discussion

The results in Tables (1 and 2) indicate that all experimental factors had significant effects on the studied indicators. However, the combination of refrigerated storage (S2) and chitosan addition (A3) showed superiority in the experiment conducted on shrub rose flowers. This could be attributed to the role of chitosan, a safe, non-toxic polysaccharide, in prolonging vase life. Chitosan promotes the conversion of sugars into carbohydrates, leading to an increase in fresh weight [16]. It may also contribute to the biosynthesis of pectin in cell walls and protect plant walls from water loss, resulting in increased water uptake and reduced water loss. These findings align with those reported by Al-Tai [4.[

As for the second experiment [gladiolus flowers], the results from Tables [3 and 4] showed the superiority of the dry storage method combined with dipping the floral stem bases in salicylic acid. This could be attributed

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to salicylic acid's role in protecting cell membranes from oxidation or its involvement in protein synthesis, which facilitates the transport of these proteins through the phloem to the flowers. This process helps extend their vase life and prevent deterioration. Additionally, its well-known role in inhibiting ethylene production likely contributed to prolonging the flowers' lifespan and maintaining their quality [5, 14 .[

Conclusion

The study demonstrated that optimal storage methods and preservative treatments significantly enhance the postharvest quality and vase life of cut flowers. Wet storage was identified as the most effective method for rose flowers, while dry storage was more suitable for gladiolus flowers. Among the preservative treatments, chitosan (A3) and salicylic acid (A2) proved to be the most effective in prolonging vase life, increasing water uptake, and maintaining flower quality by reducing water loss and enhancing carbohydrate and carotenoid content. The interaction between storage methods and preservatives yielded the most significant improvements, underscoring the importance of combining these factors for optimal results.

Recommendations

.1 For postharvest management of roses, wet storage combined with chitosan application is recommended to maximize vase life and maintain floral quality.

.2 For gladiolus, dry storage with salicylic acid treatment is suggested to achieve similar benefits.

.3 Further research should explore the molecular mechanisms underlying the role of preservatives like chitosan and salicylic acid in enhancing flower quality and vase life.

.4 Expanding this study to include other flower species and environmental conditions would provide broader insights into effective postharvest management practices.

.5 Practical training for flower producers and retailers on integrating these storage and preservation techniques is recommended to enhance the commercial value of cut flowers .

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