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The Effect of Sodıum Hypochlorite and Hydrogen Peroxide on the Vase life of Cut Rose Flowers

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Cut rose

Abstract: Cut roses are a popular choice for bouquets and floral arrangements, but their short vase life can be a significant drawback. This study investigated the use of hydrogen peroxide (H_2O_2) and sodium hypochlorite as potential treatments to extend the vase life of cut roses. Cut flowers (*R. hybrida* cv 'Samourai') were placed in glass containing solutions in six different treatments: Hydrogen peroxide (H_2O_2, 400, 600, 800 µM); Sodium hypochlorite (NaOCl, 50, 100, 200 mg L^{-1}) and distilled water as a control. Vase life, relative fresh weight, water uptake, color change of flower, flower open rate, pH and EC changes of solutions were among the parameters recorded over 15 days. According to the results, the solution containing 600 µM of H_2O_2 resulted in the highest values for vase life, relative fresh weight, water uptake, and least color change of the flowers. This was followed by the solution containing 400 µM of H_2O_2. The 50 mg L^{-1} sodium hypochlorite treatment, along with the control, resulted in the lowest outcomes in terms of vase life, water uptake, and overall flower quality preservation during the vase life period. The quality and postharvest performance of cut rose flowers were found to be significantly affected by the use of 400 µM and 600 µM H_2O_2 in preservation solutions.

Sodyum Hipoklorit ve Hidrojen Peroksidin Kesme Gül Çiçeklerinin Vazo Ömrü Üzerine Etkisi

Anahtar Kelimeler
Kesme çiçek,
Su alımı,
Hidrojen peroksit,
Sodyum hipoklorit,
Kesme gül

Öz: Kesme güller, buketler ve çiçek aranjmanlarında kullanılan önemli süs bitkilerindendir ancak kısa vazo ömürleri bu kullanımları için dezavantaj oluşturmaktadır. Bu çalışmada, farklı dozlarda hidrojen peroksit (H_2O_2) ve sodyum hipoklorit (NaOCl) kullanılarak kesme güllerin vazo ömrü üzerine etkileri araştırılmıştır. Çalışmada *R. hybrida* cv. 'Samourai' kesme çiçekleri 6 faklı uygulama içerisindeki solüsyonlara yerleştirilmiştir. Hidrojen peroksit, 400, 600, 800 µM dozları ile Sodyum hipoklorit 50, 100, 200 mg L^{-1} dozları kullanılan araştırmada kontrol grubu olarak ise distile su kullanılmıştır. Vazo ömrü, oransal taze ağırlık, toplam su alımı, goncaların renk değişimi, çiçek açılım oranı, solüsyonların pH ve EC değişimleri 15 gün boyunca izlenmiştir. Sonuçlara göre, 600 µM H_2O_2 uygulaması vazo ömrü, taze ağırlık, su alımı ve en az çiçek renk değişimi bakımından en yüksek değerlere sahipti. Bunu 400 µM H_2O_2 içeren uygulama takip etmiştir. Vazo ömrü boyunca kontrol ile birlikte 50 mg L^{-1} sodyum hipoklorit uygulaması hem vazo ömrü, su alımı bakımından hem de çiçeklerin kalitelerinin korunmasında iyi bir sonuç vermemiştir. 400 µM ve 600 µM H_2O_2 içeren vazo solüsyonlarının kullanılması kesme gül çiçeklerinin kalitesinin ve vazo ömrünün önemli ölçüde etkilendiği bulunmuştur. 400 ve 600 µM H_2O_2 uygulamalarının kesme gül çiçeklerinde vazo ömrünü uzattığı ve çiçek kalitesini koruduğu belirlenmiştir

1. INTRODUCTION

Extending the vase life and maintaining the quality of cut flowers is a crucial aspect of the floriculture industry. Factors such as water loss, ethylene exposure, microbial growth, and physiological changes can significantly impact the postharvest longevity of cut flowers [1]. Many variables affect cut flower vase life and postharvest performance [2,3]. Numerous elements influence it, such as ethylene, the atmosphere's makeup, flower handling, growing conditions, carbohydrates, blockage of the xylem channel, and chemical preservation solutions [4, 5] states that the most prevalent microorganisms in vase solutions, foliage, and stems of cut flowers are filamentous fungus, bacteria, and yeasts [6]. In the case of cut rose flowers, a common practice is to use chemical preservatives to prolong their vase life [6,7,8].

The post-harvest longevity of cut flowers is a critical factor in their successful commercialization and consumer satisfaction. Among the various flower varieties, roses are particularly susceptible to early senescence, leading to significant postharvest losses. [9]. To address this challenge, researchers have explored the use of treatments to prolong the vase life of cut roses. One potential approach is the application of sanitizing agents, such as sodium hypochlorite (NaClO) and hydrogen peroxide (H_2O_2), which have been shown to have antimicrobial properties and the ability to regulate physiological processes in cut flowers [1]. Sodium hypochlorite is a widely used disinfectant that can effectively suppress the growth of harmful bacteria and fungi, thereby reducing the risk of pathogen-induced deterioration in cut flowers [1]. Hydrogen peroxide, on the other hand, is a potent oxidizing agent that can directly impact the biochemical and physiological processes involved in flower senescence. [10]. Some studies have demonstrated that the treatment of these chemicals can significantly enhance the vase life of various cut flower species, including gladiolus and potted plants. However, there is a lack of comprehensive research on the specific effects of sodium hypochlorite and hydrogen peroxide on the vase life of cut rose flowers. The present study aims to investigate the efficacy of sodium hypochlorite and hydrogen peroxide, as cost-effective and readily available alternatives, on the vase life of cut roses.

2. MATERIAL AND METHOD

2.1. Material

Cut roses of *Rosa x hybrida* cv. 'Samourai' were used in the experiments. Early in the morning, flowering stems were taken at the tight (loose pointed bud) stage (commercial harvest stage) from a commercial grower in Şanlıurfa. In line with commercial procedures, stems were graded for consistent quality, bundled into bunches of several stems, and then recut to 35 cm in length. Within four to five hours, the bouquets were packed dry and delivered from the cultivation field to the refrigeration laboratory in commercial flower boxes. The study was carried out in the vase life room of Bingöl University, Department of Horticulture.

In order to prevent air embolism, flowering stems were trimmed to a uniform length of 35 cm under distilled water upon arrival at the laboratory. Before being used, knives were surface sterilized by being rinsed in 95% (v/v) ethanol. Hands were used to remove leaves from the lowest 20 centimeters of stems that would have otherwise been submerged in vase water. The stems were arranged at random in glass vases holding 1000 ml of test solutions at different concentrations 1000 ml of distilled water (control). As mentioned previously for cutters, ethanol was used to surface sterilize glass vases. Various concentrations of Hydrogen Peroxide (H_2O_2, 400, 600, 800 µM; Sigma) and sodium hypochlorite (NaOCl, 50, 100, 200 mg L^{-1}; Sigma) were the test solutions. Flowers were put in a controlled environment room at 12 h photoperiod (08:00–20:00 h), 60±5%, 20±1◦C, relative humidity, and provided by 15 mol photons m^{-2} s^{-1} irradiance of fluorescent lamps On the day of the vase life experiment, the solutions were prepared freshly.

2.2. Method

2.2.1. Vase life

Each flower's vase life was determined by counting the days from the day the flowers were placed to the test solutions until they lost their decorative value (color altered, wilted, and lost turgidity). The maximum width of each blossom was used to establish the flower diameter, which was then measured using a vernier caliper. Fifteen flowers were chosen for each treatment, and vase life averages were calculated.

2.2.2. Relative fresh weight (RFW;%), Total solution uptake (g $stem^{-1}$)

The average daily amount of vase solution absorbed by cut roses, vases, and flower stems was measured by independently weighing every three days. The results of subtraction were expressed in milliliters (mL). Fresh weight of flower stems was measured individually and every three days; the findings were reported as a percentage of the initial fresh weight (RFW).

Every three days the weights of the flowers and vases without flowers were measured separately. The average daily water uptake (Equality 1.) was calculated as follows:

$$\text{Daily water uptake (g stem}^{-1}\text{ day}^{-1}) = (S_{t-1}-S_t) \quad (1)$$

where St is the weight (g) of the vase solution on day t = 1, 2, 3, etc. and S_{t-1} is the weight (g) of the vase solution on the previous day. The daily water intakes were then summed to determine the total solution uptake.

2.2.3. Colour change of flowers through the vase life

Color variations were recorded from the first to the last day, and CIELAB values were calculated using a colorimeter (Lovibond; Spectrophotometer a sphere, Serie SP60).

The CIE L^*, a^*, and b* color space system was used to gather measurements, and the a* and b* values were used to determine the hue angle ($h°$) ((Equality 2.) and chroma values (C^*) (Equality 3.)

$$[h° = 180 + \tan^{-1}(b^*/a^*)] \quad (2)$$

$$[C^* = (a^{*2} + b^{*2})1/2] \quad (3)$$

2.2.4. Flower opening rate (FOR)

The bud diameter was measured every three days from day 0 for up to 9 days in order to determine the flower opening rate. An equation of [11] was adjusted to estimate the ratio of flower opening (Equality 4.)

$$\text{FOR (\%)} = \frac{\text{Flower diameter on the dn} - \text{Flower diameter on the d0}}{\text{Flower diameter on the d0}} \text{x100} \quad (4)$$

n: 0,3,6,9 the end of the measurement

2.2.5. pH and EC of solutions through the vase life

Days 0 through 15th day were used to measure the pH of the solutions using a pH/ORP meter (HI 2211 HANNA Instruments RI/USA) and a Conductivity Benchtop (Orion 3-Star, Thermo Scientific) to estimate the electrical conductivity (EC).

2.3. Statistical Analysis

The experiment was established according to the randomised plots design with 5 replications and 3 plants in each replicate. Using SPSS software, the data were analyzed using analysis of variance (ANOVA), and differences between means were examined using the Duncan multiple test (P≤0.05).

3. RESULTS

3.1. Vase Life

Although statistically significant differences were observed between the treatments in terms of vase life, Hydrogen peroxide 600 µM and Hydrogen peroxide 400 µM were in the same statistical group (P≤ 0.05). The longest vase life was determined in Hydrogen peroxide 600 µM with 12.0 days, followed by Hydrogen peroxide 400 µM with 11.60 days and Sodium hypochlorite 200 mg L^{-1} with 10.0 days. The shortest vase life was obtained from the control group with 8.0 days (Figure 1).

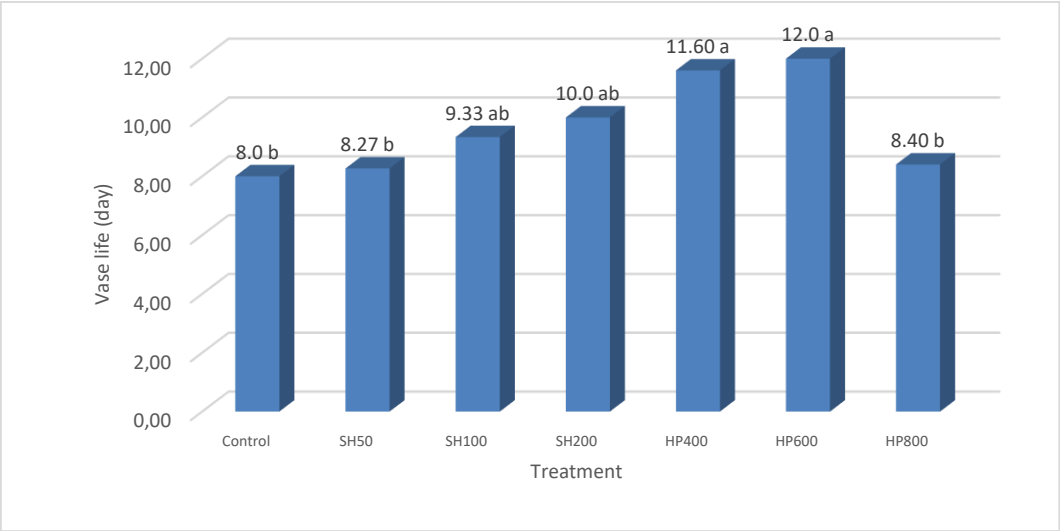

Figure 1. Effect of different vase solutions on the vase life of cut roses (SH 50; sodium hypochlorite 50 mg L^{-1}, SH 100; sodium hypochlorite 100 mg L^{-1}, SH 200; sodium hypochlorite 200 mg L^{-1}, HP 400: Hydrogen peroxide 400 µM, HP 600: Hydrogen peroxide 600 µM, HP 800: Hydrogen peroxide 800 µM).

3.2. Relative Fresh Weight (RFW;%), Total Solution Uptake (g $stem^{-1}$),

The relative fresh weight of cut roses was found to grow in all treatments (except from SH 100 treatment) until the third day, at which point it steadily dropped in all treatments (Figure 2).

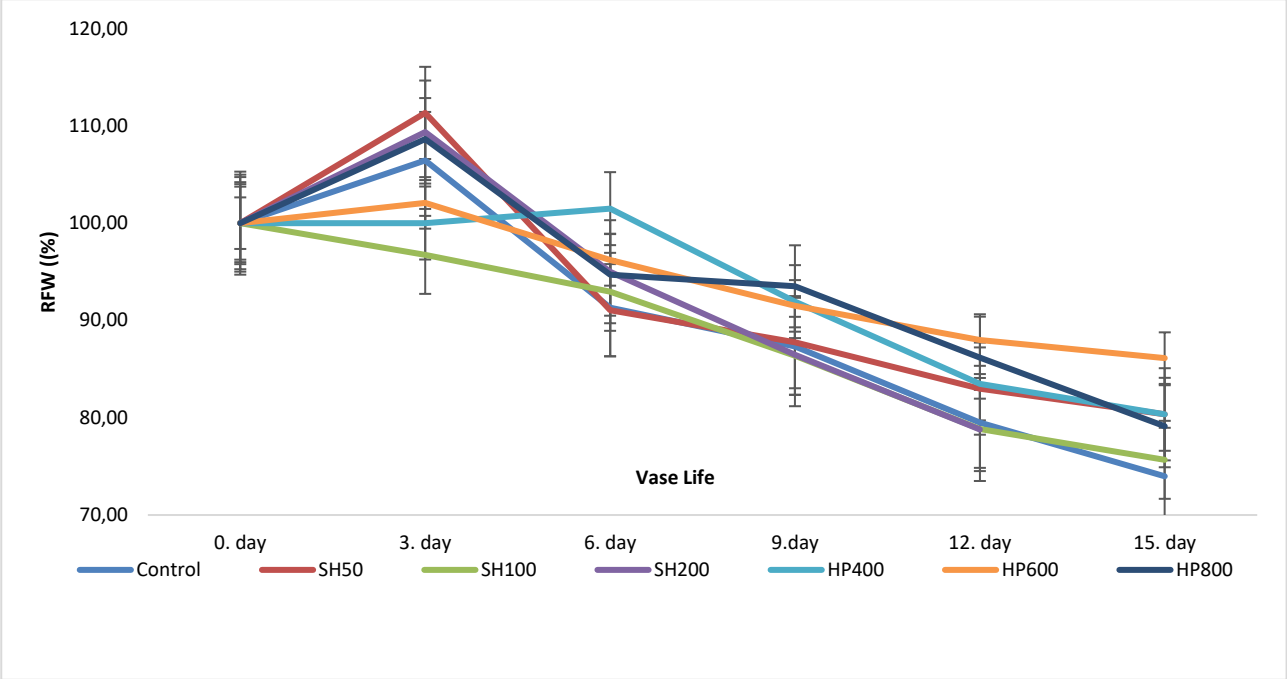

Figure 2. Effect of different vase solutions on relative fresh weight change in cut roses (SH 50; sodium hypochlorite 50 mg L^{-1}, SH 100; sodium hypochlorite 100 mg L^{-1}, SH 200; sodium hypochlorite 200 mg L^{-1}, HP 400: Hydrogen peroxide 400 µM, HP 600: Hydrogen peroxide 600 µM, HP 800: Hydrogen peroxide 800 µM).

Similar findings were obtained for solution uptake in terms of vase life results and statistically significant differences were observed between treatments in terms of total solution uptake ($P \leq 0.05$). The highest total solution uptake was determined in HP 600 treatment (58.61 g $stem^{-1}$), followed by HP 400 treatment (49.11 g $stem^{-1}$). The lowest solution uptake was realised in the control group (Figure 3).

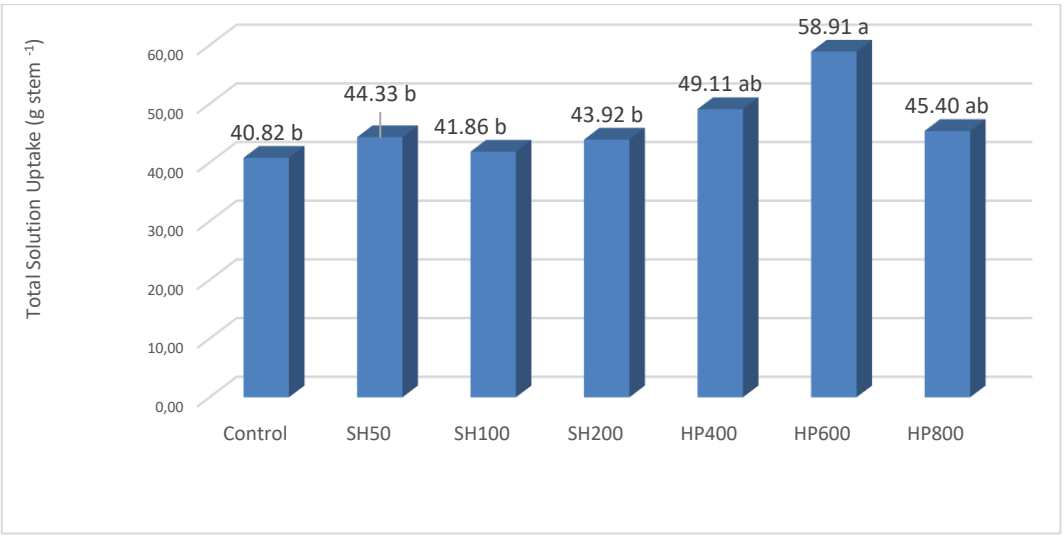

Figure 3. Effect of different vase solutions on total solution uptake in cut roses (SH 50; sodium hypochlorite 50 mg L^{-1}, SH 100; sodium hypochlorite 100 mg L^{-1}, SH 200; sodium hypochlorite 200 mg L^{-1}, HP 400: Hydrogen peroxide 400 µM, HP 600: Hydrogen peroxide 600 µM, HP 800: Hydrogen peroxide 800 µM).

3.3. Flower Opening Rate (%)

The fastest rate of flower opening was observed using sodium hypochlorite 100 mg L^{-1}, though the lowest ratio of flower opening was hydrogen peroxide 600 µM treatment. (Fig. 4).

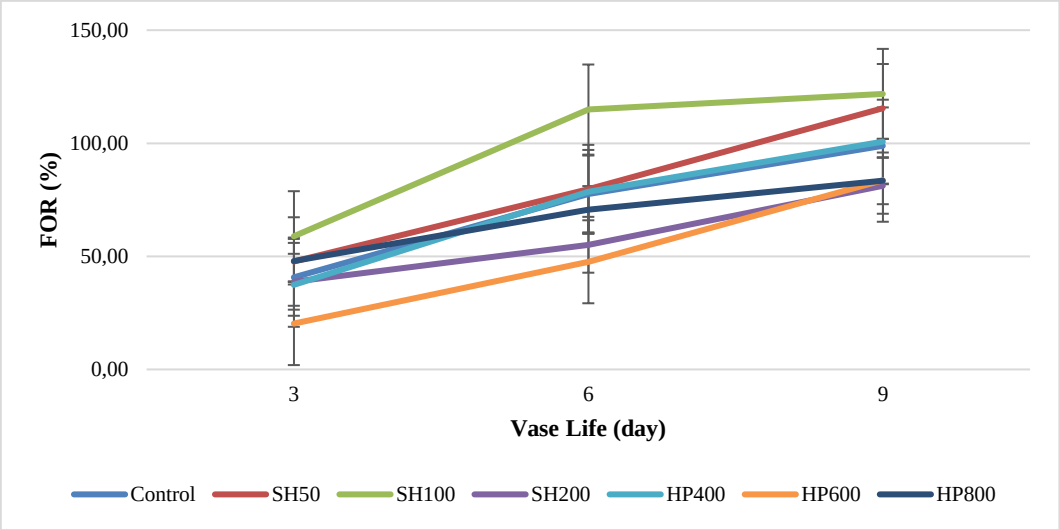

Figure 4. Flower Opening Rate (FOR) in cut roses (SH 50; sodium hypochlorite 50 mg L^{-1}, SH 100; sodium hypochlorite 100 mg L^{-1}, SH 200; sodium hypochlorite 200 mg L^{-1}, HP 400: Hydrogen peroxide 400 µM, HP 600: Hydrogen peroxide 600 µM, HP 800: Hydrogen peroxide 800 µM).

3.4. Colour Change of Flowers

Using a colorimeter, the adaxial side of each fresh petal measured during the vase life (day 0, day 6, day 12, day 15) was used to quantify each cultivar's color. The petal color was measured using the CIE *L*a*b** color space: The values of a* are red (positive) and green (negative); b* are yellow (positive) and blue (negative); *C**, color chroma (higher values denoting increased brightness); *h**, the color's hue angle between 0 and 360 [12]. *L**, the color's lightness, falls between 0 (black) and 100 (white). As each rose was viewed through a different solution, the colors were perceived differently. Brightness values (*L**) of most roses changed during the vase life (Table 1). Other variations in *L* a* b** values were seen in the study throughout the vase life of cut red roses. The fresh rose color exhibits high luminosity, or brightness, which is why the 'Samourai' cultivar of rose flowers had a high *L** value rating on the 0. day. The color turned dull and the *L* value* decreased in all treatments—including the control—when the blossom had fully faded. In general, the value of the some treatment and control increased as the flower withered and turned brown, orange, pink, or yellow in the latter days of its vase life. The *b*-value* of cut rose is positive during the vase life. Aging may cause a modest browning or yellowing of the plants. Hue angles (*h*° angle) and *C** values for red roses changed significantly during the vase life for all treatments (Table 1). The maximum color change was determined at 200 mg L^{-1} sodium hypochlorite the minimum color change was determined in 600 µM H_2O_2 (HP 600) (Table 1).

Table 1. The impact of different vase solutions on the hue angle (*h*°), chroma (C*), CIE *L*a*b** color values of cut roses throughout their vase life

Treatment	Day 0					Day 6					Day 12					Day 15				
	*L**	*a**	*b**	*h*°	*C**	*L**	*a**	*b**	*h*°	*C**	*L**	*a**	*b**	*h*°	*C**	*L**	*a**	*b**	*h*°	*C**
Control	36.5	36.5	36.5	21.87	55.6	34.3	48.5	20.64	23.0	52.8	25.0	30.79	19.2	31.9	36.3	18.4	29.5	15.0	27.0	33.1
SH50	32.5	46.7	19.7	22.86	50.6	31.8	45.9	18.4	21.8	49.6	28.1	41.39	15.0	19.8	44.0	27.4	41.3	12.5	16.9	43.7
SH100	32.8	46.4	17.1	20.20	49.4	31.1	44.5	15.84	19.6	47.4	23.9	33.01	6.72	11.5	33.7	15.7	18.1	0.99	3.13	18.1
SH200	32.7	45.9	19.7	23.26	49.9	31.5	44.3	17.32	21.4	47.5	16.2	29.29	2.79	5.4	29.4	15.8	20.4	2.5	6.98	20.6
HP400	34.1	51.9	20.4	21.43	55.7	33.7	48.7	18.9	21.2	52.2	31.9	46.63	16.8	19.8	49.6	29.9	44.7	15.9	19.7	47.5
HP600	35.7	49.7	19.7	21.65	53.4	35.2	43.7	17.88	22.3	47.2	33.6	41.8	15.3	20.1	44.5	30.8	40.7	14.9	20.1	43.3
HP800	35.6	50.4	20.5	22.10	54.4	29.6	49.3	19.45	21.6	53.0	29.3	47.47	11.5	13.6	48.8	28.7	45.3	11.1	13.8	46.7

SH 50; sodium hypochlorite 50 mg L^{-1}, SH 100; sodium hypochlorite 100 mg L^{-1}, SH 200; sodium hypochlorite 200 mg L^{-1}, HP 400: Hydrogen peroxide 400 µM, HP 600: Hydrogen peroxide 600 µM, HP 800: Hydrogen peroxide 800 µM).

4. DISCUSSION AND CONCLUSION

Cut roses are highly susceptible to water stress as the water balance in the petals is easily disturbed after harvesting and cut roses can also be affected by biotic stress causing microbiological vascular occlusion [12]. Our study reveals not only the water uptake of 'Samourai' cut roses after harvest, but also that the water relations of cut roses can be improved by adding additives to the vase solution. Placing the flowers in Hydrogen peroxide solution at a dose of 600 µM increased the vase life by 50% (Table 1), whereas H_2O_2 treatment at a dose of 800 µM caused a decrease in vase life. It is well known that H_2O_2 can cause oxidative stress at high concentrations [13, 14]. On the other hand, low H_2O_2 levels can improve resistance to a number of abiotic stressors, such as heat, drought, cold, and UV radiation. [15]. It has been found that H_2O_2 can positively regulate cut flower senescence at optimal concentrations. An essential signaling molecule, H_2O_2, is involved in many areas of plant development.[15]. Hydrogen peroxide has been shown in several scientific studies to help extend the vase life of cut flowers. In parallel with our study, a study on cut Oriental x Trumpet hybrid lilies revealed that hydrogen peroxide at a concentration of 600 µM increased the vase life of flowers from approximately 9.8 days to 12.8 days. This dose also delayed the opening time of flowers and helped to maintain chlorophyll and water content in the leaves. However, higher concentrations (800 and 1200 µM) showed negative effects. Similarly, in cut peony and gladiolus flowers, hydrogen peroxide treatments have been reported to be associated with oxidative stress and delay the vase life of flowers under the right conditions [16, 17]. A lack of study has been done on the benefits of H_2O_2 for cut flower preservation, despite the fact that it has been discovered to regulate a number of plant growth processes [18, 19, 20]. The pigments in petals showed less change in Hydrogen peroxide 400 µM, and 600 µM treatments during the vase life. Hydrogen peroxide may be an effective agent against bacterial or fungal pathogens due to its antimicrobial action, effectively limiting pathogens while maintaining water transmission and the stability of pigments in the bud. In addition, low doses of C_2H_2 oxidate may cause activation of antioxidant systems without causing damage. This may have limited the oxidation and degradation of pigments by triggering protective responses of cells against harmful effects.

Cut flowers are complicated plant organs; if the postharvest quality of the blooms is lost, the market may reject the product. This study analyzed the visual keeping quality of cut roses using flower opening and senescence. When flowering stems were immersed in 600 µM H_2O_2, they exhibited reduced flower opening and senescence in comparison to the control. This supports the earlier finding that 600 µM H_2O_2 prolonged vase life and parallels thestudy [17]. Many physiological and biochemical processes, including disruption of the water balance, deterioration of photosynthetic pigment, decrease of metabolic components, and loss of membrane integrity, are linked to the senescence of cut flowers [21, 22]. In this study, there was a significant decrease in the RFW of flowers during the vase life (Figure 2), which has also been reported by some researchers [23, 24]. Compared to the control, 600 µM H_2O_2 significantly reduced the RFW decline of the flowers placed in the vase and the relative fresh weight of the flowers was the highest in the study (Figure 2). This indicates that H_2O_2 in the vase solution reduces the water loss of flowers. In addition, studies have proved that H_2O_2 plays a role in ABA-induced stomatal closure [25, 26]. Stomatal closure is known to be associated with an increase in RFW [27]. Our results also show that the loss of fresh weight was significantly suppressed by 600 µM H_2O_2This suggests that H_2O_2 can improve the water balance of cut flowers. According to Isbashi et al. [28], H_2O_2 spraying enabled *Glycine max* L. to avoid drought stress also through the maintenance of leaf water content. The control group in the study had the greatest pH, while the SH 50 treatment on day 0 had the lowest pH. During the vase life, pH changes varied in all treatments (Table 1). The pH fluctuations observed during the vase life can potentially be attributed to the composition of the fluids inside, the transport physiology of the plant and the amount of microorganisms involved in its metabolism. Shanan [29] and Paul et al. [30] also obtained similar results in their studies. EC values increased throughout the vase life including of the control. This may be due to an increase in the amount of dissolved ions in the water, deterioration in the quality of the vase solution or increased growth of microorganisms. Cell fluids released from plant stems may also increase the EC value. In addition, as bacteria grow in the vase solution, organic and inorganic substances may be released as a result of the metabolic activities of these microorganisms, which may increase the EC value of the water.

In conclusion, the vase life and preservation quality of cut flowers were enhanced by the vase solution's ideal H_2O_2 concentrations. Among all the ageing parameters evaluated, 400 µM and 600 µM H_2O_2 treatments maintained water uptake and reduced the proportional fresh weight loss of flowers, thus increasing the vase life of flowers. This study showed that H_2O_2 at 600 µM dose can be effective in extending the vase life of cut flowers and can be used as a potential floral preservative at the end of harvest of cut roses.

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