Research Article

Comparative Study of Different Preservative Solutions for Extending Flower Quality and Market Acceptability of *Rosa hybrida* Cv. Freedom

Muhammad Ahsan[1*], Aneela Ramzan[1], Muhammad Nafees[1], Adnan Younis[2], Muhammad Amin[1], Gulzar Akhtar[3], Khansa Saleem[1] and Azka Sabeeh[1]

[1]Department of Horticultural Sciences, Faculty of Agriculture and Environmental Sciences, The Islamia University of Bahawalpur, Pakistan; [2]Institute of Horticultural Sciences, University of Agriculture Faisalabad, Pakistan; [3]Department of Horticulture, Muhammad Nawaz Shareef University of Agriculture, Multan, Pakistan.

Abstract | Amongst all the floricultural crop, Rose is one of the most important crop both economically as well as aesthetically whose beauty must be enjoyed for longer period of life. Current experiment was performed to discover the comparative consequence of various vase solutions to improve the post-harvest qualities and extend vase life of *Rosa hybrida* cv. Freedom. The research was performed at the research area of Department of Horticultural Sciences, The Islamia University of Bahawalpur. There were 11 treatments comprising of honey (T_1), sugar (T_2), salicylic acid (T_3), acetic acid (T_4), indole acetic acid (IAA) (T_5) and combination of all solutions with sugar. These treatments were compared with tap water (T_0). There were four plants in each treatment with three replications which were arranged according to completely randomized design (CRD) under room temperature. The results showed that maximum fresh weight (g) was obtained in T_4 (acetic acid), flower head diameter (mm) and flower color was ideal under T_3 (salicylic acid). Maximum dry weight (g), highest flower freshness on 1st and 3rd day, minimum petal discoloration which leads to productive market acceptability and highest vase life was recorded in T_2 (sugar). It is worth to note that lowest market acceptability of flower was observed when sugar is combined with other solution especially IAA. It means sugar reduces its effectiveness when combined with growth regulators. From this experiment, it can be concluded that sugar (T_2) provide ideal medium for enhancing the post-harvest attributes of *Rosa hybrida* cv. Freedom.

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***Correspondence** | Muhammad Ahsan, Department of Horticultural Sciences, Faculty of Agriculture and Environmental Sciences, The Islamia University of Bahawalpur, Pakistan; **Email:** ahsan.horti@iub.edu.pk
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Introduction

Roses (*Rosa hybrida*) belong to the genus *Rosa* and Rosaceae family that contains more than 2000 varieties throughout the world (Ahsan *et al*., 2017). Among these 2000 varieties, many of the species are used as cut flowers, indoor and outdoor decorations and for food preparation (Younis *et al*., 2013). Roses are at the top in the cut flower industry and exemplify a tremendous commercial cultivar throughout the world (Fanourakisa *et al*., 2013). From medicinal and nutritional perspective roses are of great importance. In the built-up of different products of medicinal and nutritional importance roses plays a vital role. Similarly, rose plant production is also a great initiative to promote cut flower business as well as

floriculture industry (Butt, 2005). The permanence in the cut flower life can be increased by using the vase life extending solutions. Addition of carbohydrates in the solution create negative environment for the flower and ultimately result in the form of loss of petal color and overcome the increased bud blasting (Susan, 2003). Cut flowers especially roses have shorter vase life. Just beneath the floral head both flowers and their axis bent down (Van Doorn *et al*., 1997). These indications are due to vascular obstruction, which prevent liquid uptake in the flowers (Loubaud and Van Doorn, 2004). The most important aim of advancing in postharvest science on the road to provide statistics for the floricultural industry which helps to provide consumers with attention-grabbing, enduring and beautiful cut flowers (Scariot *et al*., 2014).

It is well known that blockage of xylem vessels is the main reason of rose vase life reduction (Van Meetern *et al*., 2000). Stumbling block of flower stems may occur as a result of vase solution microorganism (Loubaud and Van Doorn, 2004; He *et al*., 2006), ventilation blockade (Van Lepern, 2007) and the anatomical damage healing (Williamson *et al*., 2002). Various techniques have discovered to boost the post-harvest life of flowers especially cut flowers to keep them fresh for a longer period of time (Elgimabi, 2011). Carbohydrates in the form of sugar and disinfectants in the form of germicide are the two main constituents used as vase solution. Sugar helps the flowers in respiration and germicides help to prevent bacterial attack on the conducting tissues of the flowers (Zencirkiran, 2010). Pulsing with different concentrations of sugar is very effective method in boosting-up the post-harvest life different flowers (Elgimabi, 2011). Studies showed that addition of sugar in the form of sucrose enhance the lastingness of many cut flowers, because sucrose provide a healthy diet to the flower tissues carbohydrates starvation, flowers blooming and subsequent H_2O uptake (Hayat *et al*., 2009). Defoliating effect of petal color in cut flowers is suppressed by adding sugars to the vase solution and overcome the increased bud blasting (Susan, 2003). The use of 125 mgL-1 salicylic acid the vase life was significantly extended (Fariba *et al*., 2012). Different chemical combinations with sucrose increase the post-harvest life of cut flowers and their physiological characteristics including flower size and vascular tissues (Shirin and Mohsen, 2011). Considering the above facts the current study was performed to detect the appropriate preserving mixture in order to extend the vase life of cut roses.

Salicylic acid, a plant hormone has diverse role in physiological and biological process of plants (Hayat *et al*., 2009). The word Salicylic acid (SA) was derived from Latin word "Salix", meaning willow tree (Raskin *et al*., 1990). SA is assigned contrasting regulatory rules in the metabolism of plants actually phenolic help to synchronize the plant metabolic activities (Shakirova *et al*., 2003), playing a role as a natural indicator of thermogenesis not also enhance the bud initiation in plants but also improve the physiological characteristics of plant including water and mineral uptake by roots and stomatal opening in leaves (Raskin, 1992) moreover, it also point to regulation of genes expression in the course of leaf aging (Morris *et al*., 2000). SA and sucrose addition in vase solution of roses has significantly reduced the respiration rate, alleviated humidity and improve post-harvest life of cut roses (Bayat *et al*., 2013). Besides, SA treatment is useful in enhancing the post-harvest life of many cut flowers especially roses (Hayat *et al*., 2009). Indole acetic acid (IAA) is a naturally occurring compound having a carboxyl group attached to another carbon-containing group (usually CH_2-) that in turn is considered to an aromatic ring and playing diverse roles in plants such as rooting, cell elongation and flowering (Hartmann *et al*., 2002). IAA plays fundamental function in coordination of many growth and behavioral processes in the plant life cycle such as rooting of cutting, flowering, aging, root growth, prevention or promotion of stem elongation, color enhancement of fruit and flower etc. (Khan *et al*., 2007). Honey a preservative solution also used to increase the vase life of cut flowers. It increases the vase life of cut flowers up to 7 days depend upon on the flower crops (Khan, 2015). Sugar and honey as combined solution help in keeping flower fresh and extend its vase life. Sugar with acetic acid increased fresh weight, flower diameter and flower vase life. Keeping in view the effect of these vase solutions on post-harvest attributes of floricultural crops, current study was designed to check the effects of different solutions on vase life and several post-harvest attributes of most important cut flowering floricultural crop of Rose (*Rosa hybrida* cv. Freedom).

Materials and Methods

Current experiment was performed at Department of Horticultural Sciences, University College of

Agriculture and Environmental Sciences, The Islamia University of Bahawalpur. Fresh and healthy stems cutting carrying fresh rose flower (*Rosa hybrida* cv. Freedom) was collected from Rose Garden Research Area of the university. Flowering stem samples were collected early in the morning during cool hours of the day. After brought these flowering stems to lab, these were immediately put under vase solutions which were already prepared. Preservative vase solutions including salicylic acid, Indole-acetic acid and acetic acid was purchased from the commercial scientific store of Bahawalpur. There were 10 treatments in the experiment which were compared with tap water treatment (T_0). These treatments include T_1, T_2, T_3, T_4 and T_5 consisting of honey, sugar, salicylic acid, acetic acid and indole acetic acid respectively. T_6 to T_9 comprises sugar along with all these solutions while T_{10} is combination of all these solutions. Sugar and honey was purchased from the local super store. These vase solutions were prepared in half liter of plastic bottles. All the leaflets were separated from branches which were cut back to a uniform height of 12 inches. All flowering stems were put in the bottles under the prepared vase solutions. There were four flowering stalks in each treatment which were replicated three times. There were 132 flowering stalks in the whole experiment which was arranged according to completely randomized design (CRD). Flowering stalks of all treatment were placed at room temperature (25°C) with relative humidity of 60-65%.

Plant morphological attributes studied were dry and fresh weight of the flowers (g), flower bud diameter (mm), stem diameter (mm), flower freshness score (1st day), flower freshness score (3rd day), flower color scoring, petal discoloration scale, market acceptability and vase life. Morphological parameters like fresh weigh and dry weight of the flowering stems were taken by using weighing balance. The weight of cuttings was taken in grams. Dry weight of flowering stems was taken after complete withering of flowers. The flowering stalks were dried in microwave oven at 70°C for 48 hours. Flower head diameter and stem diameter was measured by using vernier caliper and the measurements were taken in millimeter (mm). Flower freshness scoring on 1st and 3rd day was calculated on the basis of judgment by judges score 6 for excellently fresh, 4 for medium and 2 for poor freshness (Auger *et al*., 2007). For 1st day scoring of flower freshness, scoring was done after leaf removal at same day of collection. Flower color scoring was checked after dipping the flowering stems in different preservative solutions. Score 6 for excellent color, 4 for medium and 2 for poor or fade color was calculated. Petal discoloration scale was taken petals start to discolor. Usually petals start to discolor after 4 days. Maximum 8 points was given to flowers with no discolored petal flowers, 6 for discolored petals and 4 for more than 5 discolored petals. Market acceptability was checked after the stem cuttings in different preservative solutions. Market acceptability was checked after 3 days. Vase life was calculated in days which were calculated by freshness of flower its petals start to discolor.

All the recorded data was analyzed by using complete randomized design (CRD) and the treatments were studied by performing analysis of variance (ANOVA) and the means of all the 11 treatments were differentiated according to the least significant difference test (LSD) at 5% probability level (Steel *et al*., 1997).

Results and Discussion

Results indicated statistically significant (p<0.05) effect of different preservative solutions on cut rose flower (*Rosa hybrida* cv. Freedom) for fresh weight, flower head diameter, flower freshness score, flower color score, petal discoloration scale and market acceptability while non-significant for dry weight, stem diameter, flower freshness score (3rd day) and vase life (Table 1). The maximum fresh flower weight was recorded in T_0 (tap water) with value of 7.50g and T_4 (acetic acid) with value of 7.50g. Lowest value was recorded in T_7 (sugar + salicylic acid) that were 5.75g. Other treatments like T_1 (honey), T_3 (salicylic acid), T_{10} (sugar + honey + salicylic acid+ acetic acid + indole acetic acid and combination of all these treatments), T_8 (sugar + acetic acid), T_5 (indole acetic acid), T_9 (sugar + IAA), T_6 (sugar + honey) and T_2 (sugar) obtained 7.41, 7.35, 7.31, 7.15, 6.67, 6.42, 6.13 and 6.11g fresh flower weight, respectively (Figure 1). Highest flower head diameter (mm) was observed in T_3 (salicylic acid) with value of 35.74mm followed by IAA (T_5) with value of 35.23mm and T_7 (sugar + salicylic acid). Lowest value 20.91mm was recorded in T_1 (honey). Other treatments like T_4 (acetic acid), T_9 (sugar + IAA), T_8 (sugar + acetic acid), T_6 (sugar + honey), T_{10} (honey + sugar + salicylic acid + acetic acid + indole acetic acid and combination of all these treatments), T_0 (tap water) and T_2 (sugar) obtained

31.59, 29.71, 29.06, 25.25, 22.45 and 22.37mm flower head diameter (mm) respectively as shown in Figure 1.

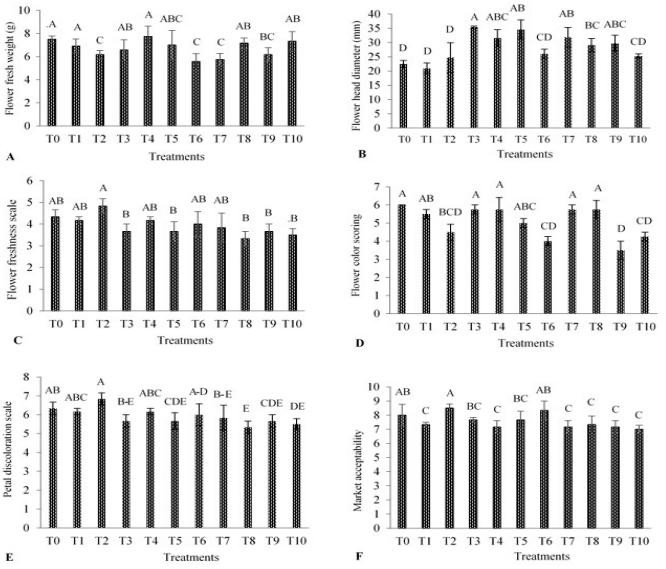

Figure 1: *Comparative impact of different preservative solutions on* **(A)** *flower fresh weight (g),* **(B)** *flower head diameter (mm),* **(C)** *flower freshness,* **(D)** *flower color score,* **(E)** *petal discoloration scale and* **(F)** *market acceptability of Rosa hybrida cv. Freedom. Different letters (A-E) exhibit significant difference among means at P < 0.05. Each mean consists of 12 samples Vertical bars shows the standard error of the experiment.*

Table 1: *Sum of squares and mean squares of different postharvest attributes of Rosa hybrida cv. Freedom by different preservative solutions.*

Parameter	SS†	MS††
Flower fresh weight	12.59	1.26*
Flower head diameter	836.16	83.62*
Flower freshness score	9.12	0.91*
Flower color score	22.53	2.25*
Petal discoloration scale	4.52	0.45*
Market acceptability	8.73	0.87**

†*SS: Sum of square;* ††*MS: Mean square;* **Significant.*

The Highest flower freshness scoring was perceived in T_2 (sugar) with value of 4.50 followed by sugar + honey (T_6) with value of 4.50 and T_0 (tap water) with value of 4.30 and T_1 (honey) with value of 3.83. Lowest value 2.95 was observed in T_9 (sugar + IAA). Other treatments like T_5 (IAA), T_3 (salicylic acid), T_4 (acetic acid), T_8 (sugar + acetic acid), T_7 (sugar + salicylic acid) and T_{10} (honey+ sugar + salicylic acid + acetic acid + indole acetic acid and combination of all these treatments obtained 3.70, 3.67, 3.43, 3.50, 3.33 and 3.00 flower freshness scoring respectively as shown in Figure 1. The Highest flower color scoring was observed T_0 (tap water) with value of 6.00 followed by T_3 (salicylic acid) with value of 5.75 and T_4 (acetic acid) with value of 5.75. Lowest value 3.50 was recorded in T_9 (sugar + IAA). Other treatments like T_7 (sugar + salicylic acid), T_8 (sugar + acetic acid), T_1 (honey), T_5 (IAA), T_2 (sugar), T_{10} (sugar + honey + salicylic acid + acetic acid + IAA and combination of all these treatments) and T_6 (sugar + honey) obtained 5.75, 5.75, 5.50, 5.00, 4.50, 4.25 and 4.00 flower color scoring respectively as shown in Figure 1.

The highest flower discoloration scale was observed in T_2 (sugar) with value of 6.62 followed by T_0 (tap water) with value of 6.33 and T_1 (honey) with value of 6.17. Lowest value 5.32 was recorded in T_8 (sugar + acetic acid). Other treatments like T_4 (acetic acid), T_6 (sugar + honey), T_7 (sugar + salicylic acid), T_3 (salicylic acid), T_5 (indole acetic acid), T_9 (sugar + IAA) and T_{10} (honey + sugar + salicylic acid + acetic acid + indole acetic acid and combination of all these treatments) obtained 6.17, 6.00, 5.77, 5.75, 5.67, 5.67 and 5.49 petal discoloration scale, respectively as shown in Figure 1. Results declared that highest market acceptability was observed T_2 (sugar) with value of 8.50 followed by T_6 (sugar + honey) with value recorded was 8.31 and T_0 (tap water) with value of 8.28. Lowest value was recorded 7.00 of T_{10} (sugar + honey + salicylic acid + acetic acid and combination of all these treatments). Other treatments like T_5 (IAA), T_3 (salicylic acid), T_1 (honey), T_8 (sugar + acetic acid), T_4 (acetic acid), T_9 (sugar + IAA) and T_7 (sugar + salicylic acid) showed 7.78, 7.77, 7.33, 7.25, 7.18, 7.18 and 7.14 market acceptability respectively as shown in Figure 1.

Fresh weight of flower is very important character about arbitrating post-harvest attributes of cut flowers crops. Present study showed maximum fresh weight of *Rosa hybrida* by acetic acid which is parallel with the results of Kazemi *et al.* (2011) and Chamani *et al.* (2012) who argued that fresh weight was increases by the addition of acetic acid in the preservative solution. Highest fresh mass of alstromeria flower was received with higher acetic acid concentration which was reported by Chamani *et al.* (2012). Growth regulators like acetic acid has direct effect of mechanism of plant metabolism and results also showed that acetic acid has beneficial effect on minerals and water transport in plants and especially necessary for the availability and transportation of micronutrients in different cut flowers (Ansari *et al.*, 2011). Flower head diameter

results were similar with the findings of Ezhilmathi *et al.* (2007) and Hajizadeh and Aliloo (2014) who concluded salicylic acid increases the flower diameter in tuberose and gladiolus. Similar effects were also noted by Kazemi *et al.* (2011) who declared that salicylic acid, citric acid and ascorbic acid on flower quality and floret diameter of different cut flower crops. Improved flower diameter was might be due to role of SA in plants physiological and biological processes (Hayat *et al.*, 2009) as it reduces the ACC synthesis and suppresses the oxidation process in different cut flower floricultural crops. A combined solution of sucrose + SA is also recommended to enhance the post-harvest attributes drastically (Gerailoo and Ghasemnezhad, 2011). Flower freshness scoring results were driven in accordance with the researches of El-Tayeb (2005) and Gunes *et al.* (2007) who noted that (sugar) sucrose-treated plants had been experienced to have good chlorophyll contents which ultimately relates to fresh appearance of the flowers. Similar findings were also observed by Shirin and Mohsin (2011) who believe on freshness of flowers were highly improved by sugar as vase solution but current is study also contradictory with the results of Shirin and Mohsin (2011) who argued that sugar combination with other chemical preservatives improved flower freshness which totally opposite with the current study. Recent researches showed that appearance (color) of flowers was enhanced by salicylic acid as elaborated by Xueping *et al.* (1999) who stated that the appearance of cut rose flowers was enhanced positively after treating with salicylic acid. Similar conclusions were also obtained by Xueping *et al.* (1999) concluded that different concentrations of salicylic acid made cut flowers more colorful and attractive than all other treatments. These results were also in line with the conclusion of Iqbal *et al.* (2012) who stated that due to growth regulators (acetic acid), flower physical appearance remains more charming and appealing for longer period of time that untreated treatments. During current experiment, petal discoloration score was less than 2.0 which was due to salicylic acid used in the vase solution. It may be due to higher / lower contents of salicylic acid in the solution. In the vase solution salicylic acid acts as germicide and sugar supplies the carbohydrates to cut flowers. Addition of sugar to the vase solution helps to controls the displeasing reactions like loss of petals color (Susan, 2003). Similar results according to current study were also noted by Mehraj *et al.* (2013) with highest petal discoloration score with different concentration of carbohydrates. Results have indicated that quality of several cut flowers is affected positively by using salicylic acid, citric acid and ascorbic acid. There might be another reason due to cultivar effect as the performance of different germplasm is different in the similar environmental conditions (Kazemi *et al.*, 2011). Therefore, salicylic acid was used to enhance the vase life and market acceptability of cut rose flowers and positive results were obtained. Different concentrations of sugar increases petal water contents resulting more freshness of flowers with high market acceptability was also obtained by Vahdati *et al.* (2012).

Conclusions and Recommendations

Sugar is an ideal preservative solution for *Rosa hybrida* cv. Freedom as it improves post-harvest characteristics in this study. Sugar (T_2) recommended as best preservative solution for flower freshness and acceptability by consumer in the flower market. It is, therefore concluded that sugar solution must be considered for experiment where other cut flowering crops are under research trials for the improvement of new post-harvest attributes and vase life.

Novelty Statement

Sugar is ideal vase life solution for improving flower quality and market acceptability of *Rosa hybrida* Cv. Freedom. It is worth to note that sugar must be applied independently (not mix with any other acidic solution) for better results and further research on other cut flowers should be under consideration for enhancement of post-harvest attributes.

Author's Contribution

Muhammad Ahsan: Conceived the idea.
Aneela Ramzan: Wrote methodology and collect data.
Muhammad Nafees: Wrote result and discussion.
Adnan Younis: Technical Input at every step.
Muhammad Amin: Data entry.
Gulzar Akhtar: Wrote abstract.
Khansa Saleem: Collected data.
Azka Sabeeh: Worked on references.

Conflict of interest

The authors have declared no conflict of interest.

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