

The Effects of Different Vase Solutions on the Postharvest Life of Rose Flower- Review

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Abstract

One of the utmost difficulties in postharvest of rose flower is the blockage of vascular system, due to air or bacterial growth, which reduces water uptake and blocks xylem vessels leading to water stress. That was expressed in the form of early wilting of leaves or flowers, and might appear when water uptake and transpiration are out of balance during a lasting period of time. This finally leads to an unrecoverable situation and the premature end of flower vase life. Antimicrobial compounds like metal salts prevent and slowdown bacterial growth, ensure proper water uptake and delay senescence. Different Preservatives solution are used to increases the longevity of many cut flowers including, sucrose as source of nutrition for tissues approaching carbohydrate starvation, Silver in the form of Silver Thiosulphate (STS) to inhibit the action of ripening/senescence hormone ethylene, aluminum sulfate to lower the pH of vase solution and as an antimicrobial agent in the solution and salicylic acid to prevent ACC-oxidase activity that is the direct precursor of ethylene and decrease ROS with increase enzyme antioxidant activity. Currently, synthetic germicides containing AgNO_3 are no longer used in commercial vase solutions because the silver can pollute the environment and cause damage to human health. Thus, it is better to use ecofriendly extracts of several plant species contain antimicrobial compound that has the potential to be used as a natural germicide in floral preservative solutions of vase cut flowers.

Keywords: Aluminum sulfate, Plant Extract, Salicylic Acid, silver thiosulphate, vase life

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1. INTRODUCTION

1.1. Back ground of study

Rose belongs to family *Rosaceae* and Genus *Rosa*, which contains more than 150 species and 1400 cultivars (Elgimab, 2011). This family is recognized highly valuable for economic benefits being the best source of raw material to be used in agro-based industry especially in the cosmetics and perfumery. Furthermore, Rose holds superiority over all other flowers as it is being extensively used for decorative purposes and is highly prized for its delicate nature, beauty, charm and aroma. In interior decoration, cut rose flowers play an important role and add charm to different occasions such as marriage ceremonies, as a symbol of sympathy, arrival and departure of dignitaries, gift on birthdays, Valentine's Day etc. Additionally, roses play a vital role in the manufacturing of various products of medicinal and nutritional importance. However, a very peculiar aspect of rose production is to get the cut flowers, which greatly deals with the floricultural business (Butt, 2003).

Now days, the floriculture industry is getting popular in developed as well as developing countries (UNCTAD, 2008). Even developing countries from Africa are highly participating in the world flower market. It is becoming the new area for growth and transformation plan of Ethiopia. But the sector has some constraints. The major problem of the horticulture sector in general and the floriculture industry in particular is the postharvest loss. Hence the crops are being alive for a certain period but they are liable to deterioration and loss. It is clear that unless they are preserved the ultimate fate of such produce is senescence and/or death. However it is possible to extend the postharvest life of flowers by using different preservative solutions. There are different vase solutions prepared to extend the life of cut flowers after harvest there by increasing the value they are going to pleasure flower minded persons and culture (Sisay, 2004). Thus this paper is initiated to review the role of different vase solution in extending the vase life of rose flower.

2. Vase Life of Roses

When flowers are cut from the mother plant, water loss from these continues through transpiration. When cut flower absorbs water from the solution it maintains a better water balance and flower freshness is maintained for long duration increasing vase life. Large amount of soluble carbohydrate are required for flower opening, yet a rose are harvested at the bud stage, limiting the soluble carbohydrate content (Ichimura *et al.*, 2003), and it is suggested that flower opening may be due to a combination of sugar uptake and degradation of various polysaccharides (Van Doorn and van Meeteren, 2003).

3. Factors Influence the Vase Life of Cut Flowers

Flower vase life is affected by respiration, carbohydrates deterioration, water balance, disease inoculation, water uptake and susceptibility towards ethylene, as ethylene shortens the vase life and leads to senescence (Kazemi,

2012).

3.1. Carbohydrates Deterioration

Carbohydrates are involved in many growth processes in plants. Structural carbohydrates are necessary for the stability of tissues and non-structural carbohydrates are obligate in providing energy, *i. e.* respiration, and as carbon skeletons for the formation of other compounds. Increased concentration of sucrose in phloem exudates upon photo induction of flowering in short- and long-day plants originates from reserve carbohydrates, not from increased photosynthesis (Van Nocker, 2001).

Petal growth is the result of cell expansion which requires the influx of water and osmolytes into the vacuole (Van Doorn, 2001). Thus, petal area as well as fresh and dry weight increase when the opening of the flower takes place. Starch is hydrolyzed during petal growth and it is important for the maintenance of cell size. During rapid cell expansion starch content is decreased and soluble sugar content increased in the petals. Carbohydrates are substrates for the synthesis of cell wall components during petal cell enlargement (Mayak *et al.*, 2001). Reducing sugars, such as glucose and fructose, are the main constituents of the sugars in mature petals. Fructose has been reported as a predominant carbohydrate during opening of flowers in roses and in *Campanula* (Vergauwen *et al.*, 2000). The level of fructose and glucose increases rapidly in petals at the time of flower opening and continues to increase until the petals are about to drop (Van Doorn, 2001).

3.2. Water Balance

Water balance determined by the difference between water uptake and water loss. In case of many flowers, wilting is the most common reason for the termination of vase life (He *et al.*, 2006). The important factor which causes wilting is water stress which occurs when rate of transpiration exceeds the rate of water uptake (Da Silva, 2003), which could be due to the blockage of xylem vessels by microorganisms or air bubbles, thus, causing flower senescence and shortening of vase life (Balestr Vaslier and Van Doorn, 2003).

Floral senescence is an active process expressed as petal in rolling, fading of colour, and wilting, caused by programmed cell death (Reid, 2012). Besides, when the stem is cut, air is immediately aspirated into all opened xylem conduits. This air will at first be restricted to the opened conduits. Since vase water bacteria cannot move from one xylem vessel to the other and polysaccharides excreted by bacteria move only partially up the stem, the blockage that occurs further up the stem is mainly due to air bubbles in the xylem conduits (Bleeksma and Van Doorn, 2003).

3.3. Disease Inoculation

Most post-harvest problems are stem end blockage, caused by air and microorganisms. Stem blockage is the main factor in imbalance between water uptake and water losses from cut flowers. Lower water uptake is commonly caused by microbes when they block the xylem vessels resulting blockage of water to the upper part (He *et al.*, 2006). Microorganisms can also produce ethylene and secrete toxic compound, also pectinase and accelerated senescence (Williamson, *et al.*, 2002)

3.4. Susceptibility to Ethylene

Ethylene is the major plant growth regulators related to senescence and can shorten the life of many floral crops, causing flower and bud drop, pre mature wilting, and flower discoloration. Many floral crops are sensitive to this common atmosphere pollutant. It is particularly insidious because it's a colorless gas that's difficult to detect and is active at minute concentrations. Ethylene is actually produced in small quantities by naturally ripening fruit and by floral crops as they age. It's used commercially to force bromeliads into flower and to hasten the ripening of fruits. But ethylene is also an activator for the normal physiological processes of aging for many floriculture crops (Anna *et al.*, 1997). Ethylene is known to be involved in the opening of rose flowers. It either stimulated or inhibited floral bud opening, depending on the cultivar (Ma *et al.*, 2006).

4. Effect of Preservatives on the Postharvest of Roses

A long postharvest life ensures that the customers – wholesalers, retailers and final consumers – will be satisfied and will return to purchase more flowers. Four major factors during both production and postharvest that influence vase life are water relations, carbohydrate status, ethylene, and pathogens (Schroeder and Stimart, 2005). Soluble sugars not only provide substrates for respiration but also act as osmotic adjusters and may suppress ethylene biosynthesis and lower ethylene sensitivity (Pun and Ichimura, 2003).

In addition to sucrose, postharvest life of most cut flowers and potted flowering plants can be extended by a range of technologies. Synthetic germicides currently added to the floral preservative solutions to prevent the growth of microorganisms in the solution. Presently, aluminium sulphate [Al₂(SO₄)₃] solutions are used as pre-treatments of cut flowers to improve vase life. A rapid pulse treatment with silver nitrate (AgNO₃) helps to alleviate postharvest problems in gerbera cultivars and extending flower vase life (Javad *et al.*, 2011). Silver nitrate reduced

bacterial contamination in the vase solutions and retarded the xylem blockage. The use of sugar + 8-hydroxyquinoline citrate (8-HQC) as a cut preservative solutions to delay flower senescence, enhances postharvest quality and prolongs the vase life up to 18 days in cut snapdragon flowers (Asrar, 2012). Similarly, butt (2005) found the use of sucrose and silver nitrate solutions prolonged vase life by 3 to 4 days in cut roses (*Rosa hybrida*). However, germicides containing AgNO_3 can pollute the environment as well as cause adverse effects on human health (Damunupola and Joyce, 2006).

The extracts of several plant species contain antimicrobial compound that has the potential to be used as a natural germicide in floral preservative solutions of vase cut flowers. The leaf extract of *Jatropha curcas*, *Psidium guajava* and *Andrographis paniculata* have antimicrobial activity as it contains phorbol esters, polyphenolic compounds, and lactones, andrographolide and kalmeghin in respectively (Rahman *et al.*, 2014; Suhaila *et al.*, 2009).

4.1. Role of Salicylic Acid on Vase Life of Roses

SA is a well-known phenol that can prevent ACC-oxidase activity that is the direct precursor of ethylene and decrease ROS with increase enzyme antioxidant activity. Mei-hua *et al.*, 2008 showed that SA can extending the vase life of cut flowers with decrease ROS and ethylene. SA acids with increases the enzyme antioxidant activity cause delay the onset of hydrolysis of structural cell components, decrease ROS production, ACC-oxidase activity and sensitivity.

Treatment with salicylic acid in combination with glutamine extends the vase life of cut rose flowers. Also, salicylic acid reduced chlorophyll total degradation and preserved chlorophyll total content. This might be inhibiting ethylene action and as a result, the vase life could be increased (Zamani, 2011).

Other study also shows the use of salicylic acid with glutamine solution, increase the vase life and decrease ACO of cut flowers. This finding also indicated that salicylic acid alone has high effect on intensification of vase life, reduction of ACC-oxidase activity and senescence of cut flowers (Zamani *et al.*, 2011).

4.2. Role of Sucrose on Vase Life of Roses

Study of combined effect of abscisic acid (ABA) and sucrose on growth and senescence of rose flowers proved that sucrose retarded and ABA promoted processes associated with senescence (Bhawana *et al.* 2013). Low carbohydrate levels in stem and leaves will reduce vase life which can be partially remedied by presence of sugar in the holding and vase solutions (Hashemabadi and Gholampour, 2006).

Sugars are essential precursors for cut flower respiration. Sucrose is the main transporting form of sugar to flower bud. The use of sucrose with or without certain additive could be of practical significance for prolonging the life of many cultivars of cut roses (Cameron and ride, 2001). On the study by Sikandar Hayat (2012), maximum flower percent fading (43.75 %) was recorded for flowers retained in vases containing distilled water (control), followed by 25.0 % fading for 2.5% sucrose solution, while minimum flower fading (15.63 %) was recorded in 7.5 % sucrose solution.

In recent study by Bhawana *et al.* (2013), sucrose mixed with 8-HQ give better results. He explained that 8-HQ, sucrose and CA treatments were effective in improving the vase life of cut roses when compared to control. Among the applied treatments, 8-HQ+CA+5% sucrose maintained vase life of cut flowers for longer period. Vase life was extended from 4th day and for control from 8th day from treated with preservatives containing exogenous sucrose. The supplementation of sucrose in the preservative solution resulted in enhanced substrate mobilization as well as utilization which led to prolonged vase life of the treated cut flowers. In a similar study on Bougainvillea flowers, keeping the bracts in vase solutions containing sucrose has been shown to vase life of flowers (Zhuo *et al.*, 2005).

In another study by Moneruzzaman *et al.* (2010), the vase life of bougainvillea bracts was significantly affected by their treatments and temperature. It was recorded that sucrose treated flowers exhibited the longest vase life compared to the control and kinetin treatments at different temperature. The longest vase life (12.8 days) was recorded in bracts with flowers containing sucrose (200ppm) solution.

4.3. Role of Silver Thiosulphate (STS) on Vase Life of Roses

Longevity of many cut flowers is negatively influenced by the presence of ethylene, which induces a variety of physiological responses, including abscission and wilting of leaves, petals and sepals. Silver thiosulphate (STS) is known to suppress autocatalytic ethylene production by inhibition of ethylene action (Da Silva, 2003).

On postharvest study of roses different concentrations of sucrose and silver thiosulfate (STS) had significantly improved the opening period of cut roses. Likewise interaction of sucrose with STS also contributes significantly. On a study by Butt (2005), Silver in the form of silver nitrate had shown a positive impact on vase life of roses. Pulsing of cut roses for 10 and 20 min with AgNO_3 improved the vase life up to 6.0 and 5.3 days, respectively.

4.4. Role of Aluminum sulfate on vase life of Roses

The role of aluminum sulfate to increase the vase life of cut flowers is not limited to lowering the pH of vase solution, also used as an antimicrobial agent in the solution (Liao *et al.*, 2001). $Al_2(SO_4)_3$ has been recommended for maintaining the vase life of several cut flowers and is used as an antimicrobial compound in commercial preservative solutions (Ichimura *et al.*, 2006). Aluminum sulfate acidifies vase solution, diminishes bacterial proliferation and enhances water uptake (Hassanpour Asil *et al.*, 2004). From a previous study effect different concentration of aluminum sulfate on solution uptake is presented in figure 1 below

In several experiments applications of aluminum sulfate alone or in combination with sucrose have kept quality and vase life of cut flowers at postharvest stage. In a study of rose postharvest life by Maryam *et al.* (2012), Aluminum sulfate (150, 300 mg/l) treated flowers had higher relative fresh weight than control and sucrose contained treatments significantly at last evaluation. 150 and 300 mg/l aluminum sulfate treatments showed significant superiority compared with control. According to his results, aluminum sulfate extended the vase life of cut rose flower compared to control.

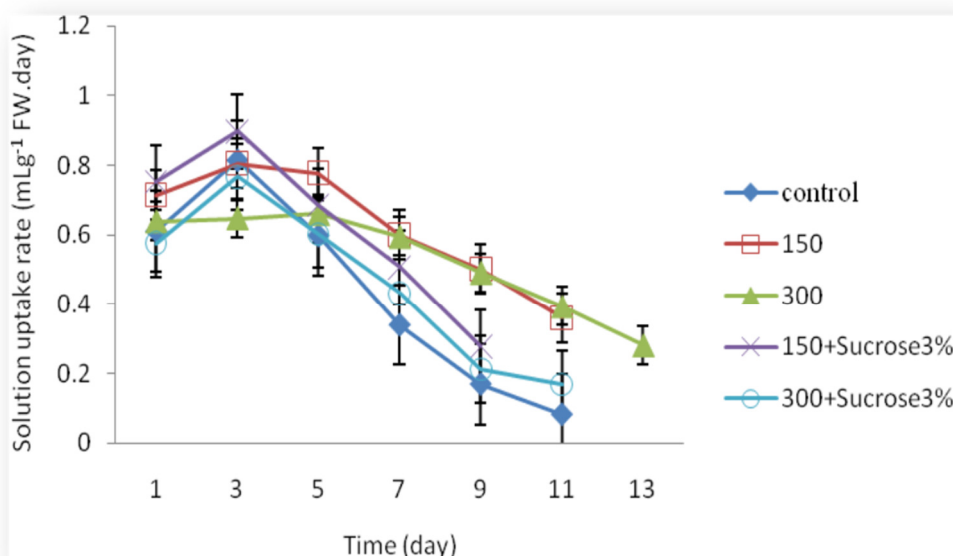


Figure 1. Effect of aluminum sulfate (0,150,300,150+sucrose 3%, 300+sucrose 3%) on solution uptake rate of cut rose (Maryam *et al.*, 2012)

4.5. Role of Plant Extract on Vase Life of Roses

The extracts of several plant species contain antimicrobial compound that has the potential to be used as a natural germicide in floral preservative solutions of vase cut flowers. *Jatropha curcas* leaf extract has antifungal activity as it contains phorbol esters and antimicrobial compounds (Rahman *et al.*, 2014). Similarly, *Psidium guajava* leaf extract showed antimicrobial activity due to its polyphenolic compounds (Suhaila *et al.*, 2009). Leaf extract of *Andrographis paniculata* contains two lactones, andrographolide and kalmeghin (Rahman *et al.*, 2014; Suhaila *et al.*, 2009). These natural products, with antimicrobial and antibacterial properties, are reasonably harmless to man. These natural products can negate the expensive and insufficient supply of synthetic antimicrobial compounds. Rahman *et al.* (2014) reported that the antimicrobial activity of *P. guajava* and *A. paniculata* leaf extracts appeared to be responsible for extending the cut flower vase life by 2 days. Both the 15mg leaf extracts of *P. guajava* and *A. paniculata* were able to control the microbes in the preservative solution, thus extending the flower vase life by reducing the pH of the preservative solution.

However, recent study shows that SLE treatments did not extend the vase life of cut flowers, because of the higher pH values of preservative solutions, resulting in lower rates of preservative solutions uptake, flower fresh weights and bud opening. In addition, fading petals was high, resulting in more floret drop (Rahman *et al.*, 2015).

The DCLE of *J. curcas*, *P. guajava* or *A. paniculata* had synergistic effects on the preservative solutions pH values. The DCLE-Jc+Ap and DCLE-Pg+Ap had synergistic effects and could hold the pH values on preservative solutions, resulting in extended vase life of the cut flowers. Concurrently, low pH values were found in 15 mg/L DCLE-Jc+Ap and DCLE-Pg+Ap preservative solutions. Moreover, flowers in the above two preservative solutions retained better petal colour than the other treated flowers. Hence, leaf extracts of *A. paniculata* in combination with *P. guajava* and *J. curcas* has the potential to minimize pH values in preservative solutions, thus extending the vase life. Nevertheless, in this study SLE had shorter vase life in preservative solutions compared to

the control containing 8-HQC. The preservative solutions contained two groups of gram-positive *Coccus* spp. and gram-negative *Coccus* spp. bacteria. There were three fungi, *Fusarium* spp., *Penicillium* spp. and *Alternaria* spp., in the preservative solutions. The 15 mg/L DCLE-Pg+Ap preservative solutions had a lower bacterial count compared to the 15 mg/L DCLE-Jc+Ap. Nevertheless, the DCLE-Pg+Ap had higher fungi growth compared to DCLE-Jc+Ap and 8-HQC. Therefore, DCLEPg+ Ap had the potential as a natural preservative solutions to extend the vase life of orchid flowers by 3 days compared to the control treatment with 8-HQC (Rahman *et al.*,2015)

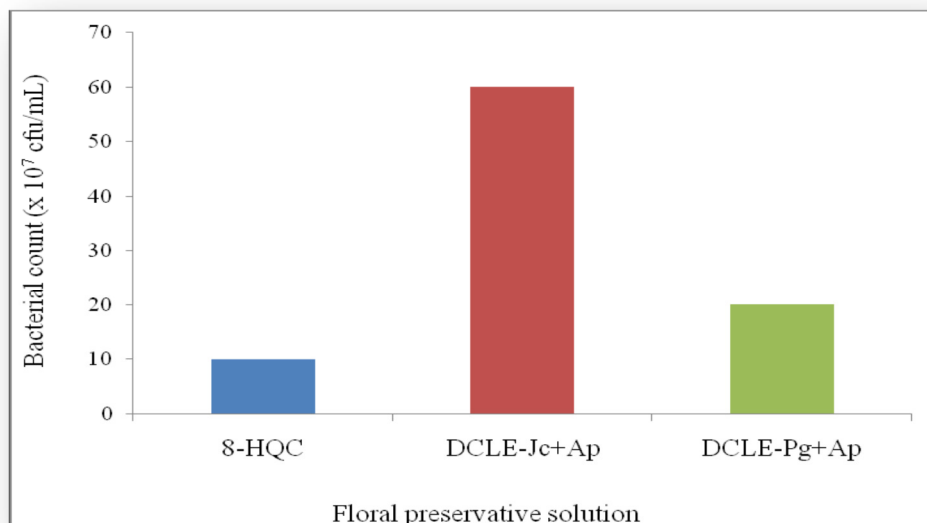


Figure 2. Bacterial counts on floral preservatives solutions containing (■) control (125 mg/L 8-hydroxyquinoline citrate, 8-HQC), and double combinations leaf extracts (DCLE) of (■) *J. curcas*+*A. paniculata* (Jc+Ap) and (■) *P. guajava*+*A. paniculata* (Pg+Ap). [Mokara Red orchid flowers; each of the floral preservative solution contains 2% sucrose and 3% citric acid. The DCLE of Jc+Ap and Pg+Ap contain 15 mg/L leaf extracts each. Means on each column, followed by different letters, are not significantly different by DMRT ($p \leq 0.05$). n=5.

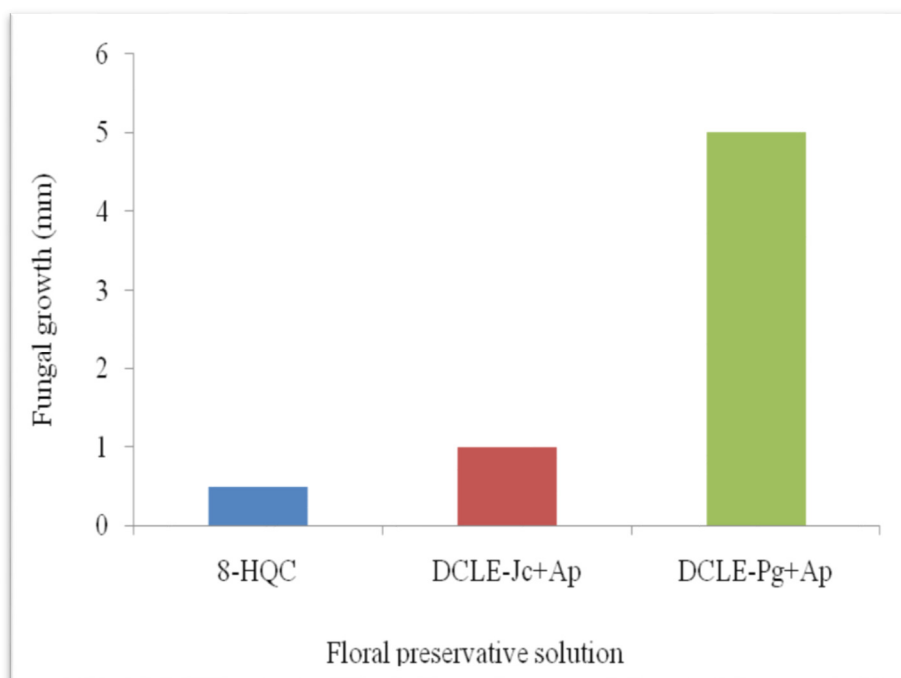


Figure 3. Fungal growth on floral preservative solutions containing (■) control (125 mg/L 8- hydroxyquinoline citrate, 8-HQC), and double combinations leaf extracts (DCLE) of (■) *J. curcas*+*A. paniculata* (Jc+Ap) and (■) *P. guajava*+*A. paniculata* (Pg+Ap). [Mokara Red orchid flower; each of the floral preservative solutions contains 2% sucrose and 3% citric acid. The DCLE of Jc+Ap and Pg+Ap contain 15 mg/L leaf extracts each. Means on each column, followed by different letters, are not significantly different by DMRT ($p \leq 0.05$). n=5.

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