Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2020; 9(1): 1185-1188
Received: 13-11-2019
Accepted: 15-12-2019

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Review on impact of different preservative solutions on vase-life of tuberose (*Polianthes tuberosa* L.) cut flowers

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Abstract
A fresh cut flower is still a living specimen even though it has been cut from the plant. As a living specimen, it conducts the regular reactions of photosynthesis and respiration, in significantly lower rates than compared to the living plant itself. The longevity of the vase life of cut flowers depends on the inability of stems to absorb water due to xylem blockage, excessive water loss from the cut flower, short supply of carbohydrate to support respiration, diseases, and ethylene gas. Tuberose cut flowers are highly perishable in nature along with acropetalus movement of the florets along the spike, when flower spikes are harvested from the plant, there will be deterioration in the internal carbohydrates and loss in turgidity is accelerated, therefore need to be treated with suitable chemicals, to enhance their vase life and improve quality. To prolong the vase life of fresh cut flowers, many preservatives have been used in the floral industry. Preservatives provide carbohydrates to cause the respiration process, supply bactericide to prevent microbial growth and blockage of the water-conducting cells in stems, and acidify the storage solution for increasing the water flow through the stem. Using a floral preservative significantly increases vase life of some flowers. The effectiveness of preservatives depends not only upon the amount of light and temperature, but also upon the amount and quality of water, types of flowers and vase load (number of flowers per vase or number of bouquets per bucket). Respiration and photosynthesis may be controlled by temperature and light. In this invention, the respiration and photosynthesis rate are controlled during the storage life through prevention of a potassium deficit.

Keywords: Tuberose, vase life, preservative, specimen, photosynthesis, respiration, perishable, acropetalus, deterioration

Introduction
Flowers are wonderful creations of nature and are of utmost importance in every sphere of human life due to their nobility, beauty, form, texture, colour and fragrance. Tuberose (*Polianthes tuberosa* L.) is an herbaceous, perennial, bulbous flowering plant, belongs to family Amaryllidaceae and is one of the most popular cut flower grown in India and as well as worldwide (Singh and Shanker, 2011) [20]. Tuberose is spreaded from Mexico to the different parts of the world during the 16th century (Tiwari and Singh, 2002) [24]. It is a flower acknowledged around the globe for its scent, appealing beauty value, shelf life and its essential oil extracts (Singh, 1995) [8]. The white, sweet scented flowers are valued as cut flower, used in bouquets for making garlands, veins and as a source of essential oils for perfumery industries. The flowers remain fresh for quite a long time and stand distance transportation and fill a useful place in the flower market (Patel *et al*., 2006) [15]. Their white colored floret has very potential demand in the markets (Dahiya 2001) [3]. The loose flowers of tuberose contain 0.080-0.135% concrete and used for extraction of essential oils which are used in high grade perfume industry (Singh *et al*., 2010) [21].
Tuberose has two main problems regarding its vase life. One is sensitivity of ethylene and the other is vascular tissues blockage (Edrisi B & Payam, 2009) [4]. Improvement of keeping quality and extend of vase life of cut flowers are important areas in floricultural research. Senescence of cut flowers is induced by several factors e. g. water stress, carbohydrate depletion, microorganism (Gowda, 1990: Van Doorn and Witte, 1991) [5]. The vase life of tuberose flowers in tap water is limited for only for few days. It has been reported that pulsing treatments prevents vascular infections and inhibit ethylene production and thereby result in prolong storage period and higher quality flowers with increased vase life (Vidhya Sankar and Bhattacharjee 2002) [27]. Water balance is determined by transpiration and water uptake and is the main factor affecting longevity and quality characteristics of cut flowers (Da Silva, 2003) [2]. In order to regulate flower supply and extension in vase life of many kinds of flowers, the use of suitable wrapping materials and chemical treatments before storage has been made with

varying success (Saeed *et al*., 1993) [19]. Packaging and storage are considered to be a critical process in enhancing the postharvest longevity of the produce (Brosnan and Sun, 2001) [3].

Floral preservative is a mixture of ingredients added to the water of a cut flowers to increase the postharvest life of flowers and the different floral preservatives significantly affected the vase life and quality of cut flowers. All preservative solutions must contain essentially two components; sugar and germicides. The sugar provides a respiratory sub-strate, while the germicides control harmful bacteria and pre-vent plugging of the conducting tissues (Abdul-Wasea A. Asrar, 2011) [1]. A major form of deterioration in cut flowers is the blockage of xylem vessels by air and microorganisms that cause xylem occlusion (Hardenburg, 1968) [6]. The 8-HQS is a very important germicide in preservatives used in floral industry (Nowak and Rudnicki, 1990) [14], and acts as an antimicrobial agent (Ketsa *et al*., 1995) which can led to increase water up-take (Reddy *et al*., 1996) [16]. Silver thiosulfate (STS) acts as an ethylene antagonist and reduces ethylene production and respiration (Veen, 1979) [26], and extends flower longevity (Reid *et al*., 1980) [18].

Cultural Influences: The forces or factors which improve crop quality before and after harvest usually improve vase life.

Light intensity is very important. A crop grown under low light, such that light is a limiting factor for photosynthesis, will be low in carbohydrate content. When carbohydrates are low, respiration is very low and flower senescence (deterioration) occurs. Optimum light intensity during growth of the crop is very important to vase life.

Temperature also influences photosynthesis and respiration, which in turn influence carbohydrate accumulation. During hot periods of the year, crops sensitive to high temperatures, have shorter vase lives because flowers contain low carbohydrate levels. When the temperature is raised to an adversely high level to force earlier flowering, the same problem occurs.

Nutrition of the crop likewise has an effect on flower longevity. Shortages or toxicities of nutrients that retard photosynthesis will reduce vase life. Deficiencies in a number of nutrients, including nitrogen, calcium, magnesium, iron, and manganese, result in a reduction in the chlorophyll content, which in turn reduces photosynthesis. The net result is a low carbohydrate supply for the flower. High levels of nitrogen at flowering time can have an adverse effect on keeping quality.

Diseases and insects reduce the vigor of the plant, directly reducing vase life. Diseases also reduce vase life indirectly: injured tissue releases large quantities of ethylene gas, which hastens senescence or deterioration of the flower.

Common reasons for early senescence are

- Inability of stems to absorb water due to blockage
- Excessive water loss from the cut flower
- A short supply of carbohydrate to support respiration
- Diseases
- Ethylene gas

Means to extend vase life of cut flowers

- Ensure that the flowers are harvested at right stage.
- Use always clean tools to cut the flowers.
- Immediately after harvesting and after transport place stem end in water or hydrating solution (citric acid 300ppm).
- Discard damaged, bruised flowers and leaves from the stem to prevent ethylene production and infection with pathogens.
- Use always clean vases, change vase water daily.
- Remove basal leaves submerged in vase solution and give basal re-cut to avoid microbial growth and plugging of xylem.
- Flowers like dahlia and narcissus release milky fluid and mucilaginous substances which spoil vase solution. Therefore, keep them in water for 24 hours before using along with other flowers.
- Adding sucrose and biocide to vase solution increases vase life of cut flowers.
- Keep vases away from source of heat, fan and near windows

Chemical Solutions: The various chemical solutions used after harvest to improve the quality of cut flowers usually have specific purposes.

Rehydration Solution: Wilted flowers, placed in water to restore turgidity, should be rehydrated with deionized water containing a germicide. Wetting agents (0.01 to 0.1%) can be added, and the water should be acidified with citric acid, HQC, or aluminium sulphate to a pH near 3.5. No sugar should be added to the solution, and rehydration should be carried out in a cooler.

Pulsing Solution: The term "pulsing" means placing freshly harvested flowers for a relatively short time (a few seconds to several hours) in a solution specially formulated to extend their storage and vase life. Pulsing solutions are specific to the individual crop. The cut flower may be pulsed with flower preservatives containing sugars, anti-microbial substances and anti- ethylene substances. Sucrose is the main ingredient of pulsing solutions providing additional sugar, and the proper concentration ranges from 2 to 20%, depending on the crop. Ethylene-sensitive flowers are pulsed with silver thiosulphate (STS). Treatments can be for short periods at warm temperatures (e.g. 10 minutes at 20 ºC) or for long periods at cool temperatures (e.g. 20 hours at 2 ºC).

Bud Opening Solution: Bud-cut flowers must be opened in bud-opening solutions before they are sold to the consumer. These solutions contain a sucrose, germicide and hormonal compounds. Foliage of some flowers (especially roses) can be damaged if the sugar concentration is too high. Buds should be opened at relatively warm temperatures (21-27 ºC), moderate humidity (60-80% R.H.), and reasonably high light intensities (15 – 30 $\mu mol.m^{-2}.sec^{-1}$ PAR).

Research Work

Adarsh Kumar (2010) [9] conducted an experiment on 'Shringar' tuberose, the treatment of 4% sucrose+300 ppm $Al_2(SO_4)_3$ tended to increase the maximum opened florets (26.00), percentage of opened florets (77.02%), solution uptake (51.00 ml) and longer vase life (10.00 days) while the change in fresh weight of spikes on 3rd day (13.69 g) and diameter of florets (4.40 cm) was registered to be the highest in spikes treated with 4% sucrose+25 ppm $AgNo_3$ The longest vase life (10.67 days) was observed in vase solution of 4% sucrose+300 ppm citric acid. Spikes wrapped in newspaper stored for 24 hours at 4 °C had maximum opened florets (22.23), per cent opened florets (74.00%) and longest vase life (7.00 day) whereas the spikes wrapped in polythene sheet and stored for 24 hours at 4 °C temperature resulted in enhanced floral diameter (4.22 cm) and water uptake (40.33 ml) at senescence.

Afroz Naznin *et al.* (2015) [13] found that the 2% sucrose + 200 mg/l $AgNO_3$ + 300 mg/l HQS+ 25 mg/l citric acid showed best water uptake, water loss uptake ratio, percentage of maximum increase in fresh weight of the cut flower stem and vase life which was extended up to 10 days in tuberose, which are suitable for prolongation of tuberose vase life.

Behrouz Eidyan (2013) observed the longest vase life was found in a combination of 150 mg·L^{-1} nitrogen, 2% (w/v) iron sulfate, and 0.1% (w/v) citric acid.

D.K. Varu and A.V. Barad (2008) [25] observed that Aluminum sulphate @ 500 ppm + sucrose @ 4% was found for longest vase life, maximum uptake of water, highest fresh weight of spike as well as lowest loss-uptake ratio and percentage of physiological loss of weight. Whereas, 8-HQS @ 400 ppm + sucrose @ 4% (C8) was observed for highest percentage of opened florets and lowest percentage of neck bent florets.

Jafar *et al.* (2011) investigated the effects of gibberellic (GA_3) acid and silver thiosulphate complex (STS) on postharvest quality of tuberose cut flowers. Vase life of cut spike was 4 days more in 40 ppm GA_3 than water control. The result showed flower vase life was significantly affected by STS concentrations and vase life was lower in 0.4 and 0.6 mM STS than in water control and other concentrations. Also, results showed that STS at higher concentrations caused severe burning of the florets. Moreover, results indicate that sensitivity of tuberose to ethylene is very little. Ethylene, therefore, may not be important in flower senescence of tuberose.

Mahroo Sadat *et al.* (2009) revealed that the best preservative solution for tuberose (*Polianthes tuberosa* L.) 'Gol Doroshi' cultivar cut flower was 2% sucrose in double distilled water, which performed significantly better than other treatments.

MJ Hutchinson *et al.* (2003) [7] investigated that the STS, BA and sucrose can help improve tuberose vase life and floret opening through improvement of the water balance. Greatest water uptake was in 10% sucrose + 25 mg L-1 BA. Transpiration losses were greatest for 25 mg L-1 BA and least for 10% sucrose. The cut flowers pulsed in 10% sucrose and held in 25 and 50 mg L-1 BA and in 2 mM STS only showed water deficit status from day 12 of their vase life.

Mohammad Mahdi *et al.* (2005) observed that the citric acid prepared with sterilized distilled water had a desirable effect on the vase life of cut tuberose flowers. This effect increased with the increment of the acid up to 450 mg l-1.

Sandrasagarren N. Naidu reported that the rapid respiration and growth of tuberose inflorescences indicate the importance of temperature management and carbohydrate supply to long vase life. A sugar containing vase preservative (1.5%) and/or pre-treatment with sugar (20% sucrose for 15-20 hours) improved display life of the stems before or after storage There was a very high correlation between vase life and stem size. Sweta Kumari (2018) [10] concluded that the combination and concentration of Sucrose 2.5% and AgNO3 15ppm were found to most suitable preservative solution for extending the vase life of tuberose cut flowers.

Conclusion

Improvement of keeping quality and extend of vase life of cut flowers are important areas in floricultural research. The vase life of tuberose flowers in tap water is limited for only for few days. It has been reported that pulsing treatments prevents vascular infections and inhibit ethylene production and thereby result in prolong storage period and higher quality flowers with increased vase life. Adding chemical preservatives to the holding solution is recommended to prolong the vase life of the cut flowers. All holding solutions must contain essentially two components; sugar and germicides. Adding chemical preservatives to the holding solution is recommended to prolong the vase life of the cut flowers. All holding solutions must contain essentially two components; sugar and germicides. Therefore, the present study was carried out with an objective to evaluate the effect of different concentration of sucrose, citric acid, $AgNO_3$ (silver nitrate), 8-HQC (8- hydroxyquinoline citrate), 8-HQS (hydroxyquinoline sulfate), GA_3 (Gibberellic acid) and STS (silver thiosulfate complex) on vase life of tuberose cut flower.

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