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RESEARCH ARTICLE

Effect of Plant Biostimulants on Vase Life of *Gladiolus grandiflora* L. cv. "White Prosperity"

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ABSTRACT

Gladiolus is one of the most cultivated cut flowers globally, but its short vase life reduces its marketability. The researchers find a lot of chemicals that enhance the vase life of this cut flower. In the current investigation, natural (organic) products are used to check their effects on the vase life of gladiolus. Lemon juice has concentrations of 10 ml L^{-1}, 30 ml L^{-1}, 50 ml L^{-1} concentration, and Moringa leaf extract with concentrations of 10 ml L^{-1}, 30 ml L^{-1}, and 50 ml L^{-1} along with 2 and 3% of sucrose. The experiment was arranged according to Complete Randomized Design (CRD) with ten plants per replication of each treatment. The present study was comprised of 6 treatments with three replications. The collected data were statistically analyzed using ANOVA techniques, using Statistix 8.1 analytical software. The comparison of treatment means was done using the Least Significant Difference (LSD) test at a 5 % probability level. Results indicated that using 30 ml L^{-1} lemon juice + 2% sucrose increased the vase life by 24.53 days, solution uptake by 78 ml, maximum of 4.2 number of florets were open during the period of basal flower senescence, while -4.83 g weight gained by this treatment. Minimum ion leakage %, the maximum number of days for basal flower senescence, and an average life of florets were greater in T_1 when 10 ml L^{-1} lemon juice + 3 % sucrose was used.

INTRODUCTION

Gladiolus grandiflora belongs to the family Iridaceae. It is indigenous to tropical and southern Africa. It is a flower that blooms during the winter and is grown for commercial cut flowers both abroad and in Pakistan. The towering spikes that the gladiolus produces, which are covered in lovely, graceful, and delicate flowers, are what make them so popular. These florets have a longer opening time in a row, which contributes to their superior cut spike holding qualities. Gladiolus floret spikes often only endure 6-7 days, which is not enough time for exporting the plant after harvesting distant markets. For cut flowers to be sold, they must be able to resist the processes of harvest, packaging, and distribution while maintaining a level of quality that would satisfy the buyer. Silver Thiosulfate, Silver Nitrate, Lanthanum, Aluminum Sulfate, 8-hydroxyquinoline Citrate and Hydrogen gas have all been used extensively to enhance the shelf life of cut flowers (Ahmad et al., 2016; Fernando et al., 2020; Ichimura and Shimizu-Yumoto, 2007). Researchers are looking at natural and environmentally safe preservative options for cut flowers because the majority of these chemicals have dangerous impacts on human health. Moringa (*Moringa olifera*) extract in gladiolus, roses (Hassan et al., 2020) guava (*Psidium guajava*), and green chiretta (*Andrographis paniculata*)

extract in mokara (Rahman et al., 2019), savory (*Satureja hortensis*) leaf extract in alstroemeria (Mohammadi Kabari and Jadid Solimandarabi, 2019), and mentha (*Mentha procera*) extract in roses, hydrogen gas for cut rose 'Movie star' (Wang et al., 2020), 8-HQS for hydrangea cut flower (Kazaz et la., 2020) have been widely used in enhancing the shelf life and cut flowers quality (Salmi et al., 2018).

The biological condition of floral tissues and endogenous sucrose levels are both affected by the usage of sucrose in the vase solution, according to the experiment of Vehniwal and Abbey (2019), results depicted that adding sugar to the vase solution helps to prolong the shelf life by maintaining rate of respiration of floral tissues in several cut flowers. As a result, adding sucrose aids in quickening floral emergence and postponing bloom senescence. It was shown that sucrose delayed senescence rather than extending vase life by increasing solution absorption. Since treating sucrose without germicides encourages bacterial growth and shortens the vase life, sucrose alone has not often been employed. According to Mashhadian and Vahdati (2012), treatment with sucrose alone without the use of germicides promoted the growth of bacteria and shortened the shelf life. In addition, citrus fruits contain bacteria that can be killed by citric acid (like lemons, limes, and oranges). The main source of citric acid (CA) is lemon and lime juice. Lemon and lime juice concentrates contain 1.10 and 1.06 grams of CA per ounce, respectively (Penniston et al., 2008). In cut carnations, it was discovered that a pre-shipment treatment including citric acid (150 ppm) applied to the pulse solution was successful. By altering the pH of the cell sap, it is likely that citric acid reduces vascular bundle blockage, enhances water balance, and intensifies petal color. Citric acid at a concentration of 0.5–0.7% in the holding solution encouraged flower growth and preserved the quality of cut tuberose spikes (Leiv and Hans, 2005).

One of the most common plant bio-stimulant is the extract of moringa leaf (MLE), which is made from the moringa plant (*Moringa oleifera*) (Phiri and Mbewe, 2010). Amino acids, cytokinins such as zeatin, flavonoids, different antioxidants and various macro- and micronutrients are all found in MLE (Rady et al., 2013; (Gopalakrishnan et al., 2016; Latif and Mohamed, 2016; Ahmad et al., 2018). Moringa leaf extract also has potent antibacterial and coagulant properties against a variety of pathogenic strains (Oluduro et al., 2010; Tesfay et al., 2017). MLE appears to be a potent, environmentally acceptable preservative for flowers due to its composition. The primary goal of current study was to investigate the effects of moringa leaf extract, lemon juice and sugar on vase life and longevity of the gladiolus cultivar "White Prosperity."

MATERIALS AND METHODS

Experimental site

The present study was carried out at Floriculture Research Area, Institute of Horticultural Sciences, University of Agriculture, Faisalabad, Pakistan in January 2021. In current investigation, *Gladiolus grandiflora* cv. "White Prosperity" was used as a research crop. The spikes were harvested early in the morning when two basal florets showed color. All of the spikes were trimmed to a standard length of 70 cm, containing an average 10 flowers per spike.

T_0	Distilled Water
T_1	10 ml/L Lemon Juice + 3% Sucrose
T_2	30 ml/L Lemon Juice + 2% Sucrose
T_3	50 ml/L Lemon Juice + 2% Sucrose
T_4	10 ml/L Moringa Leaf Extract + 3% Sucrose
T_5	30 ml/L Moringa Leaf Extract + 2% Sucrose
T_6	50 ml/L Moringa Leaf Extract + 2% Sucrose

The solution was placed into clean glass bottles. The holding solution was made using distilled water, and it remained unchanged until the experiment's conclusion. For each bottle, there were 200 ml of the holding solution. Pure distilled water made up the control treatment. The relative humidity levels were on average 60 % and the mean temperature was 12 °C ± 2 °C. During the experiment, there were 733 lux of light on average.

Vase life (days)

Vase life is time duration starting on day zero (the day the flowers were placed in the vase) and ending when their condition was deemed undesirable. The amount of wilting was measured to ascertain it. The flower's vase life is deemed to have ended when the wilting percentage exceeds 50 % and there is discoloration and petal loss (Ezhilmathi et al. 2007).

Average life of floret (days)

Average life of florets was estimated by keeping track of how many days passed between the bud opening and the floret losing its freshness. In each replication, two florets from each spike were recorded, and their average life was then calculated.

Flower opening percentage (%)

It was calculated by calculating the number of opened flowers at the end of the investigation and the percentage was calculated with unopened flowers.

Number of days to basal flower Senescence (days)

It was measured by totaling the number of days from the opening of the bud till basal florets lose their freshness.

Number of flowers open during basal flower senescence

This data was taken by counting the number of flowers that were open during basal flower senescence.

Solution Uptake (mL)

The quantity of water intake was estimated by deducting the amount of water lost from three control bottles that did not include cut flowers from the volume of water lost from bottles that did. It was measured in mL.

Fresh weight gain by flower spike (g)

At the commencement of the study, the trimmed flower spikes were weighed. A electronic weight balance was used to determine the fresh weight of cut flowers on the last day and checking the weight gained by the spikes.

Dry weight of flower spike (g)

Following vase life, the trimmed spikes were dried in an oven at 70°C for 72 hours before being weighed.

Ion leakage of floret (%)

It was taken on the final day of the vase life. Five florets or blooms that seemed to be in good condition were randomly selected from each replication and given a silica powder rubdown for this assessment. After being properly cleaned with distilled water, rubbed petals were transferred to test tubes containing 15 ml of the clean water. After 10 minutes on an orbital shaker, EC1 was identified in these test tubes. Test tubes were once more shaken on the orbital shaker for a further 100 minutes and EC2 was detected (Ahmad, 2009). Ion leakage was measured by putting the recorded reading into the following equation.

Ion leakage (%) = EC_2/EC_1 x 100

Statistical Design

The design which is used for the experiment is Complete Randomized Design (CRD) with 6 treatments having 5 replications and 3 experimental units in each replication. Using the computer program Statistix-8.1, ANOVA was performed on all the data. The Least Significant Difference (LSD) test was used to compare the mean values of the treatments at a 5% probability level (Steel et al., 1997).

RESULTS AND DISCUSSION

Vase life (days)

Figure 1 depicted that maximum vase life was obtained with T_2 (24.53 days) when 30 ml/L Lemon juice + 2% sucrose was used, followed by T_1 (22.40 days) when 10 ml/L Lemon juice + 3 % sucrose, a similar result of Ahmad and Rab (2020) they identified in experiment that effect of calcium to improve the post-harvest life of gladiolus, as result indicated that 200 mM calcium increased the vase life (12.33 days) of gladiolus spike. Mehraj et al. (2013) described that cut white snowball chrysanthemum has a maximum shelf life (13.0 days) of a flower was counted in C4 with 100 parts per million of Sucrose + lemon juice solution, this is due to the presence of citric acid in lemon juice present in vase solution helped to improve cut flowers shelf life (Vahdati et al., 2012). In addition to adjusting the pH of water, citric acid is also used to limit the development of microbes. While a significant decrease in the energy required for metabolic processes is directly tied to the senescence of cut flowers (Reid, 2012). Gupta and Kumar (2018) discussed that using 20 % sucrose the average vase life of spike was 10.33 days, while at 25% sucrose and 15% the vase life was 10 days and 7 days respectively and in control the vase life was 5 days which shows increase vase life by using sucrose. Senescence might be postponed with a simple exogenous glucose supplement (Mutui, 2002). So at the same time sucrose provide the carbohydrate content which fulfills the food requirement of plant spike, which ultimately increases the vase life of gladiolus cultivar “White Prosperity”. Our study is also related to the longest vase life of Epidendrum orchids was 21.0 days which was observed on cut flowers treated with a mixture of lemon juice, Sprite, and Rite brand bleach, 35 ml lemon juice, 45 ml Sprite (Coca-Cola Co.), and 15 ml Rite brand bleach [Shoprite Checkers (PTY), RSA] and those treated with lime juice, sugar, and Listerine (Minenhle et al., 2013). The result also showed that Moringa leaf extract also extends the vase life about control which is 16.2 days, but when 10 ml MLE + 3% sucrose, 30ml MLE+ 2% sucrose, 50 ml MLE + 2% sucrose was used the vase life of 20.31days, 21.47 days, 21.33 days respectively was increased which is similar to Akhtar et al. (2021), he found that cut spikes of gladiolus with both concentrations of MOLE, MPLE, and CPLE (2 percent and 4 percent) had longer vase lives than control (undistributed) spikes. This increase in vase life was statistically significant (P 0.05). All levels of MLE caused a longer vase life than MSE, as demonstrated by Hassan et al. (2020) the MLE level of 1:20 produced the flowers with the longest vase life, which was 13.7 days, or nearly twice as long as the control flowers. When MLE or MSE were employed at the maximum concentration, a minor loss in vase life was noticed, but it was still much higher than the control, which had the shortest shelf life.

Flower Opening Percentage (%)

As for as flower opening percentage was concerned, from the results it was noted that the maximum 76.77% flower opening was obtained with T_2 when 30 ml L^{-1} Lemon juice + 2 percent sucrose was used followed by T_5 74.24% when 30 ml L^{-1} MLE+ 2 percent Sucrose was used, T_1 with 71.11, T_6 (69.49%) with and the least (48.3 %) was obtained with control when only distilled water was used. When MOLE, MPLE, and CPLE were used at 2% and 4%, the number of open florets increased significantly compared to the control, which had more closed florets. Due to GA3's known involvement in the floral pathway development and its ability to prolong the vase life of gladiolus spikes, its presence in the MLE may be responsible for the increased number of opening buds on the spikes (Saeed et al., 2014; Cong et al., 2013).

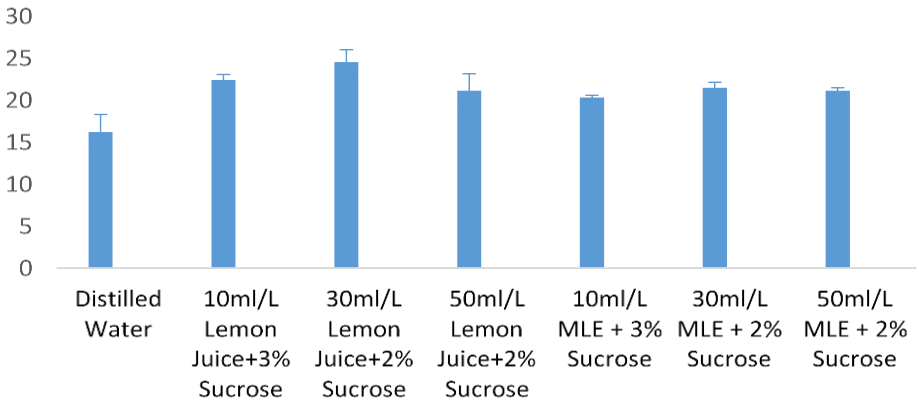

Figure 1: Effect of Lemon juice and Moringa extract along with sucrose on the Vase Life of *Gladiolus grandiflora* cv. "White Prosperity".

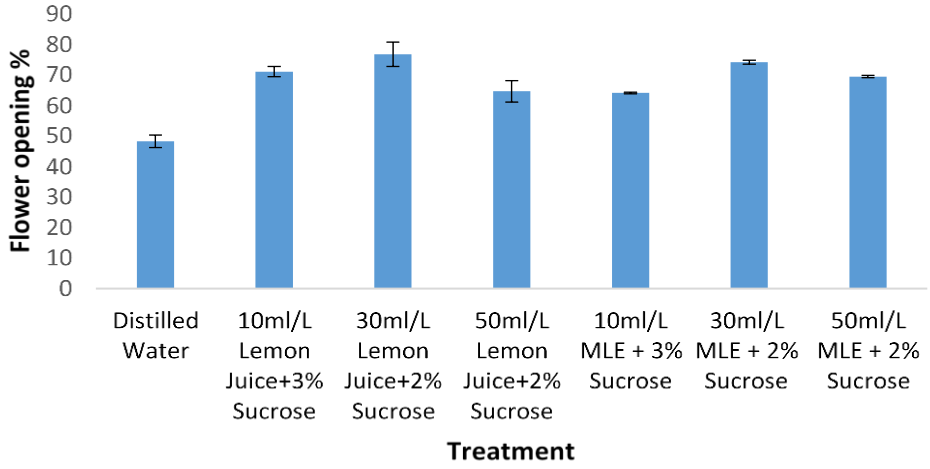

Figure 2: Effect of Lemon juice and Moringa extract along with sucrose on the flower opening percentage of *Gladiolus grandiflora* cv. "White Prosperity".

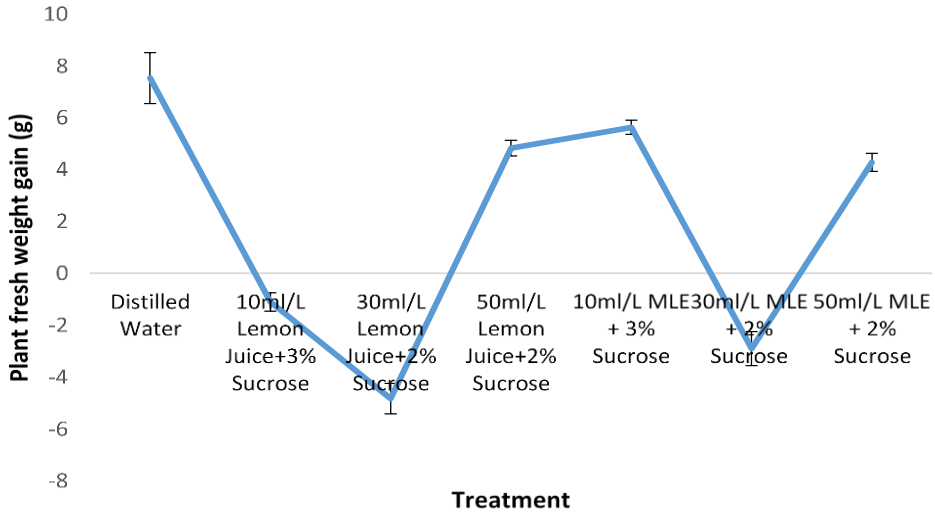

Figure 3: Effect of Lemon juice and Moringa extract along with sucrose on the plant fresh weight gain of *Gladiolus grandiflora* cv. "White Prosperity".

Plant fresh weight gain (g)

In Figure 3, maximum weight was gained in T_2 (-4.83g) when 30ml lemon juice+2% sucrose was used followed by T_5 (-2.9g) when 30 ml Moringa leaf extract + 2% sucrose was used. The maximum weight was lost in control when only distilled water was used. This is because of less uptake of solution and less flower opening percentage. When flower opening is continuing the spike life is increased and weight was also gained. This outcome was comparable to findings below. ARFW was significantly elevated at both levels (2 percent and 4 percent) of plant extracts, more so at the 2 percent level. When compared to the untreated control, it was shown that MOLE at 2 percent and CPLE at 2

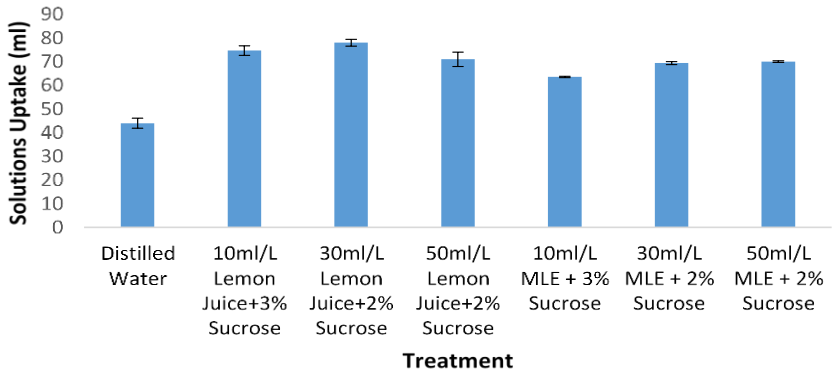

Figure 4: Effect of Lemon juice and Moringa extract along with sucrose on the solution uptake of *Gladiolus grandiflora* Cv. "White Prosperity".

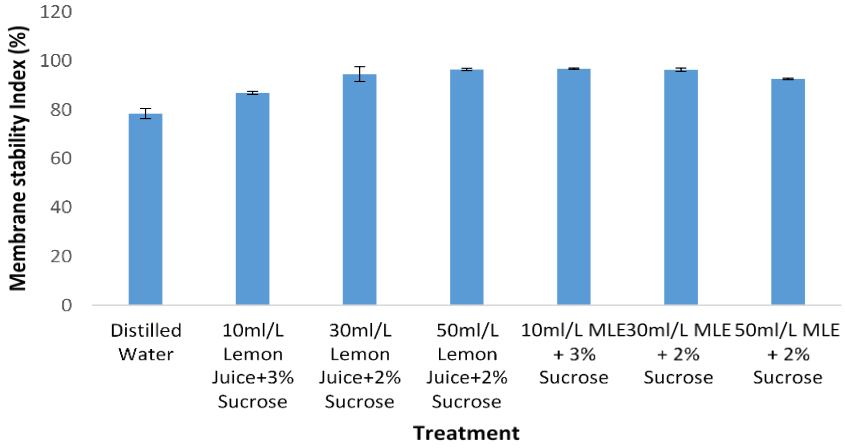

Figure 5: Effect of Lemon juice and Moringa extract along with sucrose on membrane stability index % of *Gladiolus grandiflora* cv. "White Prosperity"

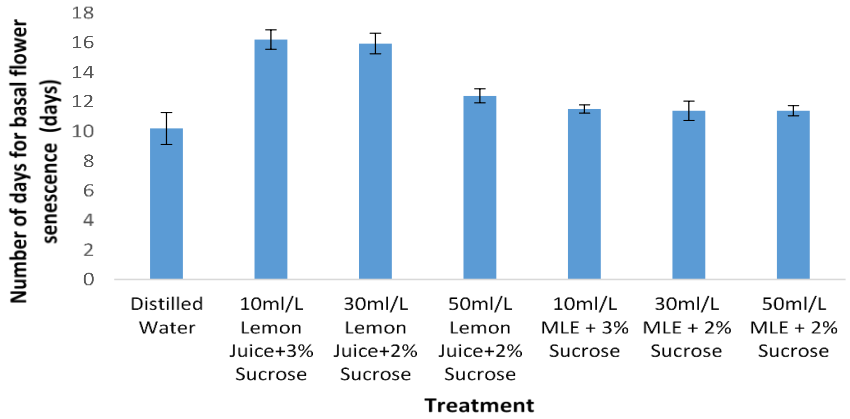

Figure 6: Effect of Lemon and Moringa extract along with sucrose on the number of days for basal flower senescence of *Gladiolus grandiflora* cv. "White Prosperity".

percent and 4 percent, respectively, had significant increases in RFW of 35, 40, and 37 percent. The spikes treated with MOLE at 4% and MPLE at 2% and 4% showed the smallest increases in RFW, with increases of 14, 8 and 10%, respectively, in comparison to the untreated control (Sheikh et al., 2015). In the trial, the combination of AA 300 mg L^{-1} and CA 100 mg L^{-1} led to the least weight loss (23%) of cut flowers. The weight loss of cut flowers under the various treatments utilized in this experiment was depicted in Fig. 1. They contend that a lower weight loss occurs as the acid content rises. Mehraj et al. (2013) discussed that minimum weight loss (7 gram) was discovered in C4 (Sucrose + Lemon juice), trailed by sucrose solution (C2; 9.2 g) and greatest weight loss (20.8 g) was recorded in C3 (Lemon juice solution). Citric acid, which is contained in lemon juice and acts as a biocide in a preserving solution and increases water absorption, has antimicrobial properties that may explain the beneficial benefits of sucrose + lemon juice solution on the shelf life of chrysanthemum cut flowers. Additionally, sucrose provides carbs to cut chrysanthemum, aiding in the loss of new weight. Lemon juice and sucrose may minimize vascular obstruction, which reduces fresh weight loss and enhances the postharvest quality of flowers. Cut chrysanthemum saw the least amount of weight loss among the treatments because it received CA and carbs from the C4 (Sucrose + Lemon Juice) treatments.

Solution uptake (ml)

Maximum solution uptake was done by T_2 (78 ml) when 30 ml/L Lemon juice was used followed by T_1 (74.67 ml) when 10ml/L lemon juice was used in Figure 4. The next is T_3 (71ml) when 50ml/L lemon juice was used. The minimum solution uptake was in T_0 control (44 ml) when only distilled water is used. The data also showed that Moringa leaf extract is also increased the solution uptake when we use more concentration of MLE and solution uptake was also increased. In T_6 when MLE 50 ml/L+2% sucrose was used the solution uptake is 70 ml while in T_5 and T_4 when 30 ml/L MLE+ 2 percent sucrose and 10 ml/L MLE+ 3% sucrose were used the solution uptake was 69.40 ml and 63.53 ml increased which was greater than control. According to Maity et al. (2019) in addition to increasing the fresh weight, water absorption also showed that nutrients and food were being supplied through the stems for the flower's development. The cut spikes of the T_4 (4 percent sucrose + 4 ppm PbSNPs) vase solution absorbed the most fluid overall (31.87 ml). According to our results, prior studies showed that MLE therapy enhanced water relationships and raised the RWC in a variety of stress-related situations (Howladar, 2014; Rady and Mohamed, 2015; Abd El - Mageed et al., 2017).

Because bacterial xylem blockage significantly reduces water intake (Loubaud and van Doorn, 2004; Balestra et al., 2005), the decline in bacterial population in the vase of spikes treated with moringa leaf extract (MLE) may be another reason why water relations have improved. MLE's powerful antibacterial activities against multiple pathogenic strains are probably what caused the gladiolus vase solution to have fewer microorganisms (Oluduro et al., 2010; Tesfay et al., 2017). Additionally, CA's anti-embolism property, which is brought on by a decrease in bacteria and a reduced risk of vascular obstruction, can reduce water uptake and lengthen vase life (Bhattacharjee et al., 1993). A lowered pH has traditionally been thought to extend the life of flowers in vases, according to other researchers, and the majority of flower preservers include an acidifier that lowers the pH of the vase

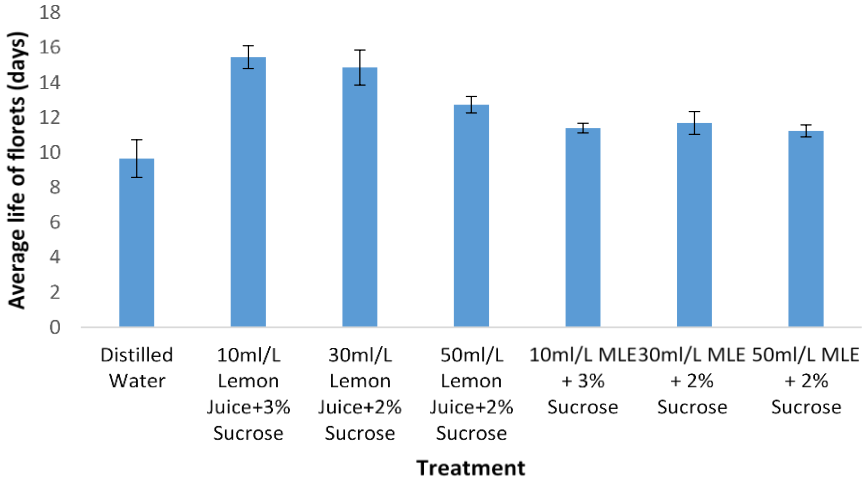

Figure 7: Effect of Lemon and Moringa extract along with sucrose on the average life of florets of *Gladiolus grandiflora* cv. "White Prosperity".

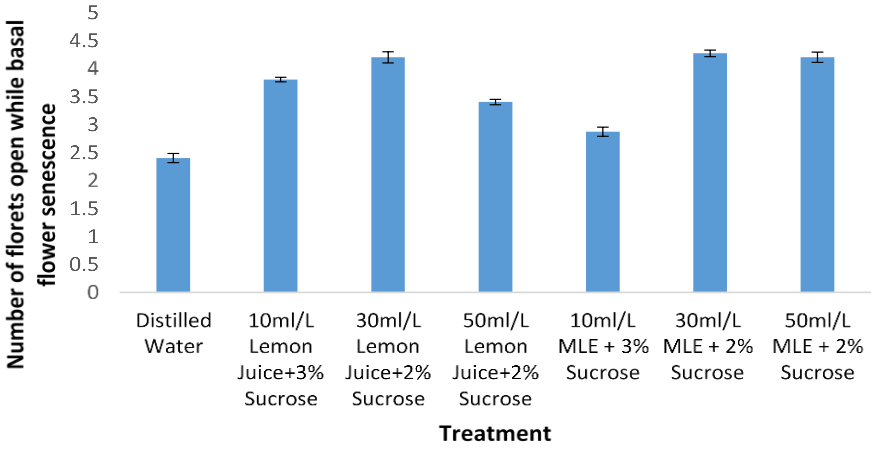

Figure 8: Effect of Lemon juice and Moringa extract along with sucrose on the number of florets open while basal flower senescence of *Gladiolus grandiflora* cv. "White Prosperity".

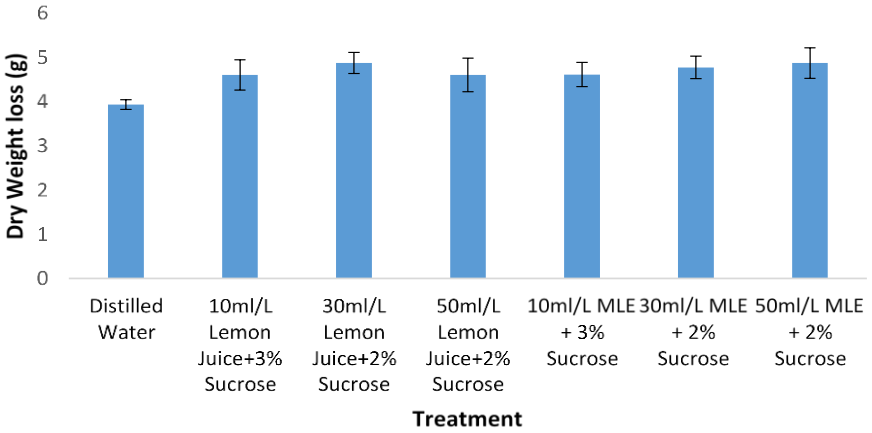

Figure 9: Effect of Lemon juice and Moringa extract along with sucrose on dry weight loss % of *Gladiolus grandiflora* cv. "White Prosperity".

Table 1: Comparison of postharvest attributes for vase life of *Gladiolus grandiflora* cv. "White Prosperity".

Treatment	Vase life (Days)	Flower opening %	Solution Uptake (ml)	Ion Leakage	Number of days for Basal flower senescence	Average life florets	Number of florets of open while basal flower senescence	Weight loss (g)	Dry weight (g)
T0	16.20E	48.30 E	44.00D	78.39A	10.20 C	9.64D	2.40D	7.53A	3.93B
T1	22.40B	71.11B	74.67AB	86.85F	16.20 A	15.44A	3.80AB	-1.10C	4.60A
T2	24.53A	76.77A	78.00A	94.52D	15.93 A	14.85A	4.20A	-4.83E	4.87A
T3	21.13CD	64.66CD	71.00B	96.42B	12.40 B	12.72B	3.40BC	4.83B	4.60A
T4	20.31D	64.14D	63.53C	96.76B	11.51 B	11.39C	2.87CD	5.63B	4.61A
T5	21.47BC	74.24AB	69.40BC	95.35C	11.40 BC	11.68C	4.27A	-2.90D	4.77A
T6	21.533C	69.49BC	70.00BC	92.59E	11.40 C	11.22C	4.20A	4.28B	4.87A

Means sharing similar letters in a column are statistically non-significant (P>0.05)

solution. The acidifying and stress-relieving actions of ASA are thought to be responsible for the increases in water absorption and, consequently, cut flower fresh weight (Hatami et al., 2010). Vehniwal and Abbey (2019) discovered that water stress, which results from the cessation of a constant supply of water at harvest, is the most frequent reason for cut flower vase life being too short. The different tissues in the cut flower tissues may compete with one another for water as a result. Consumers may not like flowers if they droop and prematurely wilt owing to a water imbalance caused by constant water loss through transpiration. As a result, the development of buds and blooming is dependent on factors including the proper water balance and turgor

level. Cut flowers and foliage have a shorter vase life due to water loss, which also accelerates early ripening, senescence, browning and frost damage. The pace of stomata perspiration, as well as the kind and nature of the solutes in the vase solution, are more significant factors in determining the shelf life of cut flowers. The sugar in the vase solution was known to help lower the rate of transpiration.

Membrane stability Index (%)

As for as membrane stability index % was concerned, from the results it was observed that the maximum membrane stability index was in T_4 which is 96.76 % when 10ml/L MLE+3% sucrose was used, followed by T_3 at 96.42 % when 50 ml/L Lemon juice+ 2% sucrose was used, and in T_5 is 95.35 %, in T_2 was 94.52 %, while minimum in T_0 78.39 % when only distilled water was used. Our findings were in line with Akhtar et al. (2021), who discovered that exposing gladiolus cut spikes to various concentrations of plant extracts from the plant's *M. olifera, M. piperita*, and *C. procera* substantially (P 0.05) preserved the floret membrane stability index (MSI percent). A significant rise in MSI of 22 and 20 percent, respectively, over control, was seen in treated spikes with MOLE at 2 and 4 percent. Hassan et al. (2020) findings further demonstrate that untreated flowers rapidly lost the integrity of their membranes, as seen by a substantial decline in MSI (61 percent at day 8) with flower aging. The impact was more obvious with moringa leaf extract application (MSI was 88 percent with moringa leaf extract (MLE) against 83 percent with MSE on day 8). MLE or MSE treatment overcame such detrimental effects and preserved the MSI in comparison with untreated flowers.

Number of days for basal flower senescence (days)

The number of days for basal flower senescence is varied statistically as shown in Table 1. The maximum days taken for the basal flower senescence was in T_1 (16.20 days) when 10ml/L lemon juice+ 3 % sucrose was used, followed by T_2 (15.93 days), T_3 (12.40 days), T_4 (11.51 days) when 30 ml/L lemon juice +2 % sucrose, 50 ml/L Lemon juice +2% sucrose, 10ml/L MLE + 3 % Sucrose respectively was used. The minimum days for basal flower senescence was in T_0 (10.20 days) when only distilled water was used. Jamal Uddin et al. (2016) identified that in control 5.5 days were taken for basal flower senescence and when using 3 % sucrose + 100 ppm STS the days were 12.4, and 12.1 days when 3% sucrose + 100 ppm SA and 11.8 days when 3% sucrose + 100 ppm citric acid was used but when a higher concentration of sucrose 5%+100 ppm citric acid was used the days for basal floret senescence was 10 days which is significantly different from % sucrose + 100 ppm citric acid concentration.

Average life of florets (days)

Figure 7 showed that the difference in average life of florets which was highest in T_1(15.44 days) followed by T_2, T_3, and T_5 which was 14.85 days, 12.72 days and 11.68 days respectively, while the minimum in T_0 which is 9.64 days. Since the average of florets is generally higher than the control treatment, this also depicted that the spike vase life is also increased. Al-Hasnawi et al. (2019) found that growth regulators have a significant role in the shelf life of cut flowers. The GA_3 (50 mg/l) considerably enhanced the relative fresh weight, water absorption, and balance of the water which ultimately increase the average life of florets compared to control.

Number of florets open while basal flower senescence

The data shown in Table 1 depicted that a maximum number of florets was open while basal flower senescence was in T_5 when 4.27 flower buds were open followed by T_2, T_6, and T_1 which is 4.2, 4.2 and 3.8 flowers respectively, while the minimum was in T_0 which is about 2.4 flowers. Jamal Uddin et al. (2016) show that the no of floret open while basal floret senescence was higher at 10.5 in T_4 when 3% sucrose + 100 ppm STS, followed by 10.4, 10.4 3% sucrose + 100 ppm citric acid, 3 percent sucrose + 100 ppm salicylic acid respectively. The maximum number of florets opened when 30ml/L moringa leaf extract + 2% sucrose was used. This is due to the existence of Gibberellic acid in MLE and at the same time, sucrose provides the essential energy due to which quick opening of florets takes place. According to Kumar et al. (2014), abscisic acid and gibberellin levels in the petals may potentially influence floret opening, with a greater ABA/GA3 level perhaps resulting in an earlier floret opening. Hassan and Ali (2014) discovered that the application of ethylene action inhibitors, such as silver thiosulphate (STS) or 1-methyl cyclopropane (1MCP), enhanced the number of open florets.

Dry Weight Loss (g)

The data showed that maximum dry weight loss was in control which is 3.93 g while minimum weight loss was in T_6 which was 4.87 g followed by T_2, T_5, T_4, T_3, and T_1 which is 4.87, 4.77, 4.61, 4.60, and 4.60 grams respectively, which also described that natural homemade preservatives are good for enhancing the shelf life of Gladiolus cut flower. According to Al-Hasnawi et al. (2019) the treatment of flowers with growth regulators has considerably contributed to the effect on the quality of Gladiolus cut flowers. The results showed that the treatment of GA_3 (50 mg L^{-1}) significantly surpassed the rest of the other treatments by giving it the highest dry weight and maintaining the flower quality.

In conclusion, post-harvest parameters like vase life, solution uptake, weight gained, ion leakage, and floret opening % were increased by lemon juice due to the presence of citric acid and sucrose application, which indicated the vital role of citric acid and nutrient source.

The result also depicted that moringa leaf extract also increased the vase life of gladiolus cv. White Prosperity. For commercial uses, low-cost preservatives are always essential, and as a result, there is a great deal of interest among researchers in creating natural, eco-friendly preservatives for cut flowers.

Author's Contribution

All authors contributed equally to this study.

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