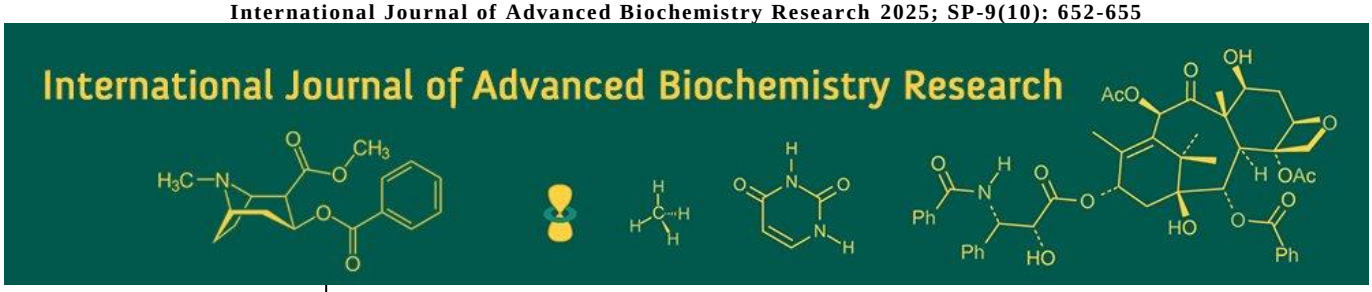

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Evaluating the effectiveness of innovative preservation solutions for cut flower gladiolus (*Gladiolus grandiflora* L.)

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Abstract
The present experiment was carried out to evaluate the "Evaluating the Effectiveness of Innovative Preservation Solutions for cut flower Gladiolus (*Gladiolus grandiflora* L.)'' was conducted during the Rabi season of 2024-25. The experiment involved laboratory studies. The experiment was conducted at the floriculture and landscaping laboratory under Pt. Kishori Lal Shukla College of Horticulture, and Research Station, Rajnandgaon (C.G.). Mahatma Gandhi University of Horticulture & Forestry, Durg (C.G.). A complete random design was used for statistically analysed of data, which consisted of 10 treatments and replicated thrice. The Red majesty flower variety was used in this experiment. The treatments comprised Citric Acid, Ampicillin capsule, Rifampin capsule, tamarind juice, coconut juice, lime juice along with a distilled water control. Solutions were prepared by dissolving the required amount of preservation solution in 1 L of distilled water. The treatment 9 (Rifampin capsule 300 mg + coconut juice 30 ml + tamarind juice 30 ml + lime juice 30 ml/L) recorded the lowest Physiological Weight Loss (11.7%), and Maximum Diameter of Floret (9.3cm), and maximum Floret opening (97.8%), and longest vase life (8.5 days), and The greatest water loss (34.0%) occurred in Treatment T5 (Ampicillin capsule 250 mg + coconut juice 30 ml + tamarind juice 30 ml + lime juice 30 ml/L). In contrast, the untreated control (T_0) consistently recorded inferior values across all traits. The study concludes that treatment 9 (Rifampin capsule 300 mg + coconut juice 30 ml + tamarind juice 30 ml + lime juice 30 ml/L is the most effective treatment for prolonging of vase life of gladiolus.

Keywords: Gladiolus, Rifampin capsule, ampicillin capsule, coconut juice, lime juice, tamarind juice, vase life

Introduction
Gladiolus (*Gladiolus grandiflorus* L.), commonly known as the "Queen of Bulbous Flowers" or "Sword Lily," is one of the most glamorous and commercially important cut flowers worldwide. It belongs to the family *Iridaceae* and is admired for its vibrant spikes, elegant florets, and wide range of colors, forms, and sizes (Mishra P. and Khana A., 2019) [10]. The genus Gladiolus comprises over 255 species and more than 10, 000 cultivars. Its widespread appeal has resulted in high demand, particularly during cultural and festive events such as Valentine's Day, Christmas, and Mother's Day (Sarje *et al*., 2024) [13].

One of the main causes of the decrease in vase life is microbial blockage of xylem channels, which inhibits water intake. The blockage is caused by bacteria and fungi that grow in the stem and vase solution, which causes wilting and early senescence. However, microbial contamination can be significantly reduced while preserving good water conductivity by using the right biocides. (Sowjanya Anugula, 2021) [14].

Synthetic antimicrobials like ampicillin and rifampin have also been shown to effectively inhibit microbial growth in vase solutions. While rifampin inhibits the synthesis of RNA, ampicillin, a broad-spectrum βlactam antibiotic, stops bacteria from making cell walls. By lowering bacterial growth at the cut stem end, their application to floral preservatives enhances water absorption, minimises xylem obstruction, and increases flower turgidity.

The mixture of these antibiotics with natural bioactive compounds such as tamarind, lime, and coconut juice would be synergistic in promoting vase life extension and flower quality enhancement.

The use of antimicrobial agents, such as essential oils, antibiotics, and natural juices, has been seen to preserve cellular integrity and enhance water uptake in cut flowers Synthetic antimicrobials such as ampicillin and rifampin have also proved to prevent microbial growth in vase solutions.

Natural products such as tamarind juice, lime juice, and coconut water are found to possess promising potential as floral preservatives because of their bioactive content. Tamarind (Tamarindus indica) fruit pulp contains very high levels of tartaric acid, reducing sugars, pectin, dietary fiber, and tannins. These compounds are responsible for its well-documented antifungal and antibacterial activities, and thus it is active against such pathogens as Candida albicans and Aspergillus niger (Doughari, 2006) [3]. Lime juice, being a natural citric acid, is a good acidifier as it reduces the pH of vase solutions, preventing microbial growth and promoting water absorption (Penniston *et al*., 2008) [12]. Coconut water, easily accessible in rural settings, has natural cytokinins plant hormones that retard senescence, inhibit ethylene-induced aging, and promote water absorption and cell turgor of cut flowers (Elgimabi and Ahmad, 2009) [4].

The use of floral preservatives is one of the most cost-effective techniques to prolong the vase life of gladiolus. These preservative solutions commonly include germicides, acidifiers, and energy sources like sucrose to improve the longevity and quality of cut flowers. Various chemical compounds, such as 8-hydroxyquinoline citrate, sodium hypochlorite, citric acid, and aluminium sulphate, have shown promising results in enhancing flower quality and increasing vase life. However, such chemical preservatives are expensive and often unavailable in rural markets, limiting their use by small-scale farmers. There is, therefore, a growing interest in exploring low-cost, easily available, and ecofriendly alternatives using locally sourced materials.

Materials and Methods

The present study, titled entitled "Evaluating the Effectiveness of Innovative Preservation Solutions for cut flower Gladiolus (*Gladiolus grandiflora* L.)'' was conducted during the Rabi season of 2024-25. The experiment involved laboratory studies. The experiment was conducted at the floriculture and landscaping laboratory under Pt. Kishori Lal Shukla College of Horticulture, and Research Station, Rajnandgaon (C.G.).

Chhattisgarh is located between 17°14'N-24°45'N latitude and 79°30'E 84°15'E longitude. Rajnandgaon situated on the bank of Shivnath and falls between 21°10'N latitude and 81°03' E longitude at a height of 307 meter over the mean sea level.

The experiment was laid out in a Completely Randomized Design (CRD) with 10 treatments and 3 replications. Each treatment included 10 flower stalks. The Red majesty flower variety was used in this experiment. Experiment was carried out with the 10 treatment T_0 Control (Distilled water), T_1 (Citric Acid 200 PPM), T_2 (Ampicillin capsule 250 mg + tamarind juice 30 ml/L), T_3 (Ampicillin capsule 250 mg + coconut water 30 ml/L), T_4 (Ampicillin capsule 250 mg + lime juice 30 ml/L), T_5(Ampicillin capsule 250 mg + coconut juice 30 ml + tamarind juice 30 ml + lime juice 30 ml/L), T_6 (Rifampin capsule 300 mg + tamarind juice 30 ml/L), T_7 (Rifampin capsule 300 mg + coconut water 30 ml/L), T_8 (Rifampin capsule 300 mg + lime juice 30 ml/L), T_9 (Rifampin capsule 300 mg + coconut juice 30 ml + tamarind juice 30 ml + lime juice 30 ml/L), Solutions were prepared by dissolving the required amount of preservation solution in 1 L of distilled water.

Result and Discussion

1. Physiological Weight Loss (%)

The data presented in Table 1 and fig. no .1 the observation on physiological weight loss (%) was calculated based on the initial and final weight of gladiolus spike. The physiological weight loss of the respective treatments is presented in Table 1. The minimum physiological weight loss (11.7%) was recorded in treatment T_5 (Ampicillin capsule + coconut juice 30 ml + tamarind juice 30 ml + lime juice 30 ml) and T9 (Rifampin capsule + coconut juice 30 ml + tamarind juice 30 ml + lime juice 30 ml), which were found at par with treatment T_4 (Ampicillin capsule + lime juice 30 ml) that recorded 12.1% loss. These treatments showed better performance in reducing weight loss and were statistically superior to several other treatments. In contrast, the maximum physiological weight loss (17.2%) was observed in treatment T0 (control-distilled water), which was significantly higher than many other treatments.

2. Diameter of Floret (cm)

The data presented in Table 1 and fig. 1, Among the various treatments, treatment T_9, comprising Rifampin capsule 300 mg, coconut juice 30 ml, tamarind juice 30 ml, and lime juice 30 ml per liter, exhibited the largest floret diameter (9.3 cm), followed by T_5, which included Ampicillin capsule 250 mg, coconut juice 30 ml, tamarind juice 30 ml, and lime juice 30 ml per liter, with a diameter of 8.7 cm. Notably, the shortest floret diameter (6.7 cm) was seen in treatment T_0 (distilled water), likely attributable to reduced carbohydrate availability and water absorption in this treatment. The synergistic effect of antibiotics, natural acids, and synthetic agents contributed to the maintenance of water balance, which likely enhanced carbohydrate levels and floret turgidity, hence resulting in increased diameter under these treatments. These results closely align with the findings of Tamrakar *et al*. (2018) [15], who likewise saw an increase in bloom diameter with the application of coconut water and cow urine compared to the control in Gladiolus.

3. Floret opening (%)

The florets opening percentage in a gladiolus spike was found significantly differed among the different vase solutions of antibiotics, natural acid and synthetic floral preservative and data are presented in Table 1 and depicted in Fig.1. It is clear from the data presented in Table 1 that significantly maximum florets opening percent of gladiolus spikes 97.8%) was recorded in treatment T_9 i.e. Rifampin capsule 300 mg + coconut juice 30 ml + tamarind juice 30 ml + lime juice 30 ml/L which was found at par with treatments T_5 i.e. Ampicillin capsule 250 mg + coconut juice 30 ml + tamarind juice 30 ml + lime juice 30 ml/L (94.7%) and T2 i.e. Ampicillin capsule 250 mg + tamarind juice 30 ml/L (90.3%). Whereas, significantly the minimum opening florets percent of gladiolus spikes (73.1%) was noted under treatment T_0 (distilled water). The decreased microbial growth in the vase solution and the prevention of vascular blockage may have contributed to the increased floret opening percentage in the treated spike. This was achieved by facilitating the uptake of the solution. Different antibiotics, natural acids, and synthetic floral preservatives

were employed. The results are consistent with Vahdati *et al*. (2012) [16] in the case of chrysanthemum.

4. Vase Life of Spike (Days)

The data presented in Table 1 and arranged graphically in Fig. 1 The treatment T_9, which consisted of Rifampin capsule 300 mg, coconut juice 30 ml, tamarind juice 30 ml, and lime juice 30 ml/L, exhibited the significantly longest vase life (8.5 days). This treatment was statistically comparable to T_5, which consisted of Ampicillin capsule 250 mg, coconut juice 30 ml, tamarind juice 30 ml, and lime juice 30 ml/L, and had a vase life of 8.3 days. The vase life was considerably minimum (5.7 days) with treatment T_0, which is "Distilled water." Vase life with the application of different preservative probably attributed to sufficient carbohydrates and good water balance under this treatment. Floral preservatives enhance the process of photosynthesis and also helpful for extent vase life. Present finding are in conformity with Lanza, H. 2006 and Van doorn 1998 in rose. The effect of antibiotics helped in reduction of bacterial population in vase solution and increased the water conductance in xylem of flowers spike. Hence, solutions that contained antibiotics ultimately increased its vase life of gladiolus spike. Similar results also observed by Hashemabadi *et al*. 2013 [6] in chrysanthemum. Citric acid may kill bacteria of a solution, for an acidifier, citric acid is readily available and inexpensive. It is present in citrus fruits. Lemon juice and lime juice are rich source of citric acid (Penniston *et al*., 2008) [12].

5. Water Loss (%)

The data on water loss percentage in gladiolus spikes subjected to different concentrations of antibiotics, natural acids, and chemical preservative solutions during the vase period are illustrated in Table 1 and Figure 1.The findings indicate that the type of preservative solution employed had a significant impact on water loss from the treated spikes. The greatest water loss (34.0%) occurred in Treatment T5 (Ampicillin capsule 250 mg + coconut juice 30 ml + tamarind juice 30 ml + lime juice 30 ml/L), which was statistically comparable to Treatments T9 and T8. The control treatment T0 (tap water) exhibited the lowest water loss percentage at 26.7%.

The increased water loss in treated spikes is due to enhanced water uptake and hydraulic conductivity, resulting from the incorporation of antibiotics and natural acid substances in the vase solution. These additives prevent vascular blockage, sustain xylem function, and enhance overall water relations in cut spikes. As water absorption increases, a corresponding increase in loss through transpiration occurs. Similar findings have been documented by Jalili Marandi *et al*. (2011) [7], Padaganur *et al*. (2005) [11], and Burt (2004) [2], indicating that enhanced water uptake is associated with greater water loss. Amin A.O. (2017) [1] observed that specific preservative solutions can decrease the transpiration rate by partially closing stomata. Al-Humaid (2008) confirmed that antibiotics, including penicillin and streptomycin, significantly improve the postharvest quality of Gladiolus hybridus by preserving optimal water relations.

Table 1: Effect of preservation solutions on different vase life parameters of cut flower gladiolus (*Gladiolus grandiflora* L.).

Notations	Treatment Details	Physiological Weight Loss	Diameter of Floret	Floret Opening	Vase Life of Spike	Water Loss
T_0	Control (Distilled water)	17.2	6.7	73.1	5.7	26.7
T_1	Citric Acid 200 PPM/L	13.9	6.9	82.3	6.3	27.6
T_2	Ampicillin capsule 250 mg + tamarind juice 30 ml/L	13.4	7.2	90.3	7	28.8
T_3	Ampicillin capsule 250 mg + coconut water 30 ml/L	17.1	7.2	90.2	6.9	28.3
T_4	Ampicillin capsule 250 mg + lime juice 30 ml/L	12.1	7.1	89.1	6.7	28.3
T_5	Ampicillin capsule 250 mg + coconut juice 30 ml + tamarind juice 30 ml + lime juice 30 ml/L	11.7	8.7	94.7	8.3	34
T_6	Rifampin capsule 300 mg + tamarind juice 30 ml/L	13.9	6.9	85.5	6.5	28.1
T_7	Rifampin capsule 300 mg + coconut water 30 ml/L	13.4	7.2	93.1	7	29.7
T_8	Rifampin capsule 300 mg + lime juice 30 ml/L	13.8	7.3	94.2	7.2	30.7
T_9	Rifampin capsule 300 mg + coconut juice 30 ml + tamarind juice 30 ml + lime juice 30 ml/L	11.7	9.3	97.8	8.8	33.6
Sem±		0.6	0.13	1.57	0.22	1.4
CD at 5%		1.65	0.4	4.64	0.64	4.2

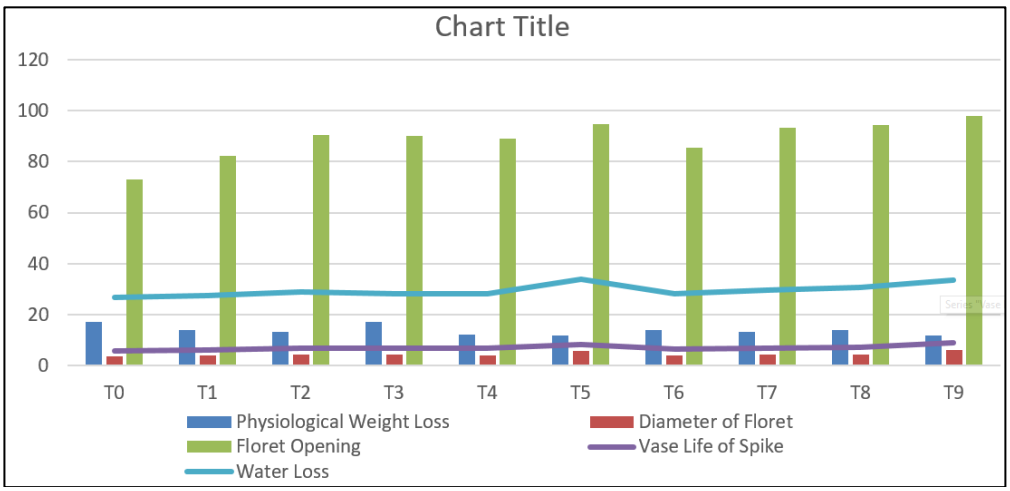

Fig 1: Effect of preservation solutions on different vase life parameters of cut flower gladiolus (*Gladiolus grandiflora* L.).

Conclusion

From the present research, it can be concluded that among all the treatments 9 (Rifampin capsule 300 mg + coconut juice 30 ml + tamarind juice 30 ml + lime juice 30 ml/L is the most effective treatment for prolonging of vase life of gladiolus. This treatment significantly enhanced vase life) recorded the lowest Physiological Weight Loss and Maximum Diameter of Floret and maximum Floret opening, and longest vase life. The greatest water loss occurred in Treatment T_5 (Ampicillin capsule 250 mg + coconut juice 30 ml + tamarind juice 30 ml + lime juice 30 ml/L). The untreated control performed the worst across all parameters. Therefore, the use of Rifampin capsule 300 mg + coconut juice 30 ml + tamarind juice 30 ml + lime juice 30 ml/L can be recommended as a suitable preservative solution for enhancing the vase life, market value, and commercial acceptability of gladiolus cut flowers.

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