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Study on postharvest life of cut gerbera flowers as affected by different organic and inorganic preservative solutions

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Abstract
The present experiment entitled "Study on postharvest life of cut gerbera flowers as affected by different organic and inorganic preservative solutions" was conducted to determine the best combination of preservative solutions for cut gerbera *cv* stanza during the season of Rabi at Indira Gandhi agriculture university Raipur (C.G).The statical design that was followed for the execution of this experiment was completely randomized design (CRD) with three replications. The effect of essential oil with different chemical preservative was investigated. Data were recorded for solution uptake, capitulum diameter, petal water content, microbial count, membrane stability index, Vase-life and analysed statistically. Combination of Thymus oil 5 mg/l+ citric acid 300 ppm + sucrose 4% were most effective treatments for enhancement of quality attributes of cut gerbera flowers.

Keywords: Vase life, *Gerbera jamesonii*, Thymus oil

Introduction
Gerbera jamesonii, sometimes known as Barberton daisy or African daisy, is a Mexican native. Gerberas are perennial herbs with no stems. The leaves are radical, lanceolate, strongly lobed, and occasionally leathery, smaller at the base and broader at the top, and grouped in a rosette at the base. Vase-life is frequently employed as a measure of cut flower lifespan after harvest. Cut flowers have a shorter vase life because they are susceptible to substantial postharvest losses. As a result, there are a lot of scope to create post-harvest technology that is particular to each cut flower in order to get a higher market price.
Based on scientific concepts, the extension of cut flower vase life through enhanced post-harvest management and care has now become commercially and economically essential. Nutrient shortage, bacterial and fungal contamination, water stress-induced wilting, and vascular obstruction are the main causes of cut flower vase life shortening. Preservatives should be added to holding solutions to extend the vase life of cut flowers. Most floral preservatives contain carbohydrate, microbicide, ethylene inhibitors, growth regulators, and mineral compounds. The apparent lack of information paved a way for the present study entitled study on post-harvest life of cut gerbera flowers as affected by different organic and inorganic preservative solutions.

Material and Method
The present study was conducted at the Department of floriculture and landscape architecture, Indira Gandhi Krishi Vishwavidyalaya during the year 2021-22. The fresh cut gerbera flowers were harvested from the PFDCs farm, which is 2-3 km far from Indira Gandhi agriculture university Raipur. The stalks of gerbera flowers were cut when 2-3 whirls of stamens had fully formed.
After harvesting, cut gerbera flowers were kept in fresh water to retain their freshness and turgidity. The cut ends of the gerbera were wrapped up with moistened cotton in little plastic bags, cut gerbera flowers were then stored in polythene bags with care after that cut gerbera were placed within a CFB box before being transported to the lab. There was 14 treatment combinations i.e. (T_0) Tap water(control), (T_1) Sucrose 4%, (T_2) Citric acid (300 ppm), (T_3) Calcium chloride 4% + sucrose 4%, (T_4) Thymus oil (5 mg/l) + citric acid (300 ppm), (T_5) Thymus oil (5 mg/l) + citric acid (300 ppm) +sucrose 4%, (T_6) Chitosan (100 ppm) + citric acid (300 ppm), (T_7) Chitosan (100 ppm) + calcium chloride 4%, (T_8) *Aloe vera* gel 4% + citric acid (300 ppm), (T_9) *Aloe vera* gel 4% + calcium chloride 4%, (T_{10}) Hoagland solution

50% + citric acid (300 ppm), (T_{11}) Hoagland solution 50% + calcium chloride 4%, (T_{12}) Coconut water 5% + citric acid (300 ppm), (T_{13}) Coconut water 5%+ calcium chloride 4%.
The experiment design was a completely randomized with 3 replication and 14 treatments. The flowers were placed in glass bottles containing 250 ml of previous mentioned chemical preservative solutions as well as tap water as a control treatment and kept in room temperature at (25±2 ºC) for 13 days.

Data Recorded
Solution uptake: (The uptake of vase solution was assessed by subtracting the solution in the flower vase at the end of the day from the flower vase of original solution in ml.

Capitulum diameter: The diameter was determined by measuring the diameter of the capitulum from the back of capitulum at sepal of flower by tangent using a common scale.

Petals water content (% WP) can be calculated with the given equation (Kalate Jari *et al*., 2008).

% WP= {(FW-DW) ÷ DW} × 100,

Membrane stability index: To assess the stability of the petal membrane, two samples of petals, comprises of 200 mg of each replication, were weighted and dipped in 10 ml of distilled water. For 30 minutes, one was held at 40 ºC, and for 15 minutes, at 100 ºC. The electrical conductivity of the solutions was measured using an EC metre once the samples reach to room temperature, and the membrane's stability percentage was then computed. (Ezhilmathi *et al*, 2007) [9].

Membrane stability index (%) = 1-(value A-value B) × 100

Microbial count: (On day 11, samples from the vase solution of gerbera flowers were collected in sterile containers then distributed in 25 microliter quantities on sterile nutrients agar in sterile petri plates, the aliquots of the vase solutions were 100 times diluted. After 48 hours of being left at room temperature, the microbial population of the plates was checked and colony forming unit were counted.

Vase-life: (Wilting of flower petals is the major factor that reflect as the end of cut flower vase life. The gerbera flowers were observed in the interval of odd days for the symptom of degradation.

Results
Solution uptake per flower has been recorded maximum in T_5 (79.20 ml) and minimum in T_0 (47.4 ml). From the beginning of experiment to day 8 of the shelf life, solution uptake increases in all solutions then decreased. Flowers that was kept in T_5 (Thymus oil 5 mg/l+ citric acid 300 ppm+ sucrose 4%) showed significant increment (Table 1).
Capitulum diameter in all treatment was increased in the initial days of placement and then it started decreasing but the reduction of diameter in control was started from the beginning. Flower treated with the combination of T_5 (Thymus oil 5mg/l+ citric acid 300 ppm+ sucrose 4%) was recorded with highest capitulum diameter (8.9 cm). The capitulum diameter of flowers in all tested solutions were significantly higher than control (Table 1).
Petal water content of all the treatment was higher in the initial days of placement but decreases with the passing of days. However, this decrease was significantly lower than control. Flower treated with the combination of T_5 (Thymus oil 5 mg/l + citric acid 300 ppm+ sucrose 4%) was recorded with highest petal water content (65.5%) followed by T_4 (Thymus oil 5 mg/l + citric acid (300 ppm) while the minimum petal water content was recorded in T_0 (37.1%).
It was observed from the data that treatments T_2 (citric acid 300 ppm), T_4 (Thymus oil 5 mg/l+ citric acid 300 ppm), T_5 (Thymus oil 5 mg/l+ citric acid 300 ppm +sucrose 4%), are free from fungal and bacterial contamination. While the treatment T_0 (Tap water) have (32 cfu/ml) with highest number of colonies forming unit (Table 2).
Membrane stability index from the beginning of the experiment in all solutions were reduced. However, the rate of decreasing membrane stability in all the treatments was lower than control (Table 2) The treatment T_7 (Chitosan 100 ppm+ calcium chloride 4%) recorded with 80.0% of stability at par T_5 (Thymus oil 5 mg/l+ citric acid 300 ppm+ sucrose 4%) with 79.9%. While, the minimum stability was obtained from T_0 (control).
Vase-life of flowers was maximum from the treatment T_5 with (13.3 days) followed by T_4 (12.6) days and T_6 (11.2) days while the minimum vase-life was obtained from T_0 with 5.4 days. The combination of (Thymus oil 5 mg/l + citric acid 300 ppm + sucrose 4%) was proved to be beneficial for enhancing the vase life of cut gerbera flowers.

Discussion
Uptake of water plays an important role in the postharvest quality of cut gerbera flowers. Anjum *et al.* (2001) [10] suggested that by adding a suitable germicide in the vase solution can prevent the growth of microbes and subsequently increased the water uptake.
Increase in capitulum of gerbera might be due to antifungal and also antibacterial property of essential oil. Bacterial accumulation in the stem lead to vessels plugging which can be hinder by antibacterial property (Kazemi *et al.*, 2010) [11]
Stem breakage is caused due to increase in the microbial activity as per the finding of (Balestra *et al.* 2005) [12] as the application of thyme oil (*Thymus vulgaris*) with combination of sucrose and citric acid increased the content of water in the petal and reduce the resistance flow also keep the flowers fresh for longer duration.
Hydrophobic nature of essential oils allows the division of lipids of bacterial cell wall and mitochondria, disrupting the structure of cell making them more permeable. The phenolic compound affects the microbial structure, resulting in inflammation of the cell.
Treatment of natural compound (oil) is helpful for protecting the cell physical structure against the antioxidant damage which is likely to be caused by reactive oxygen species by enhancing the antioxidant property. Hence membrane stability gets increased Chanjirakul *et al.* (2004).
Citric acid was used in various researches to achieve low pH levels in vase solution. These results are in close conformity with the finding of (Aarts, 1957; Penningsfeld and Forchthammer, 1966; Kofranek and Kubota, 1972; Kofranek *et al.* 1975) [13, 14, 15, 16]. Essential oil enhances the vase-life of cut gerbera flowers by its antifungal and antibacterial property and also maintaining water turgidity and balance for extending vase-life.

Table 1: Effect of different organic and inorganic preservative solution on quality parameters of cut gerbera flowers *cv*. Stanza

SN	Treatments	Solution uptake (ml)	Capitulum diameter (cm)	Petal water content (%)
T_0	Tap water (control)	47.48	3.52	37.1
T_1	Sucrose 4%	60.30	4.20	46.9
T_2	Citric acid (300 ppm)	58.30	3.90	45.8
T_3	$CaCl_2$ 4% + Sucrose 4%	65.80	4.43	43.2
T_4	Thymus oil 5 mg/l + citric acid (300 ppm)	77.46	8.14	54.1
T_5	Thymus oil 5 mg/l + citric acid 300 ppm+ sucrose 4%	79.20	8.92	65.5
T_6	Chitosan 100 ppm + Citric acid 300 ppm	64.00	6.46	58.7
T_7	Chitosan 100 ppm + $CaCl_2$ (4%)	60.70	6.34	56.6
T_8	*Aloe vera* gel 4% + citric acid (300 ppm)	52.60	5.71	43.3
T_9	*Aloe vera* gel (4%) + $CaCl_2$ (4%)	59.60	5.09	40.9
T_{10}	Hoagland Solution (50%) + Citric acid (300 ppm)	56.90	4.03	40.6
T_{11}	Hoagland solution (50%) + $CaCl_2$ (4%)	55.60	4.06	40.4
T_{12}	Coconut water (5%) + Citric acid (300 ppm)	65.70	7.33	46.2
T_{13}	Coconut water (5%) + $CaCl_2$ (4%)	65.76	7.24	44.4
	S.Em ±	1.12	0.16	1.16
	C.D.at 5%	3.13	0.48	3.38

Table 2: Effect of different organic and inorganic preservative solution on quality parameters of cut gerbera flowers *cv*. stanza

SN	Treatments	Microbe population (cfu /ml)	Membrane stability index (%)	Vase life (days)
T_0	Tap water (control)	32	40.1	5.4
T_1	Sucrose 4%	18	48.3	7.4
T_2	Citric acid (300 ppm)	0	54.5	7.6
T_3	$CaCl_2$ 4% + Sucrose 4%	16	59.9	8.4
T_4	Thymus oil 5 mg/l + citric acid (300 ppm)	0	78.7	12.6
T_5	Thymus oil 5 mg/l + citric acid 300 ppm + sucrose 4%	0	79.9	13.3
T_6	Chitosan 100 ppm + Citric acid 300 ppm	12	78.8	11.4
T_7	Chitosan 100 ppm + $CaCl_2$ (4%)	14	80.0	11.2
T_8	*Aloe vera* gel 4% + citric acid (300 ppm)	30	51.4	8.3
T_9	*Aloe vera* gel (4%) + $CaCl_2$ (4%)	28	55.3	8.6
T_{10}	Hoagland Solution (50%) + Citric acid (300 ppm)	19	52.0	6.2
T_{11}	Hoagland solution (50%) + $CaCl_2$ (4%)	14	57.2	6.6
T_{12}	Coconut water (5%) + Citric acid (300 ppm)	9	72.0	10.3
T_{13}	Coconut water (5%) + $CaCl_2$ (4%)	6	72.4	10.8
	S.Em ±	0.45	1.50	0.14
	C.D.at 5%	1.32	4.38	0.41

Fig 1: Measurement of solution uptake of cut gerbera flowers

Fig 2: Measurement of capitulum diameter of cut gerbera flowers

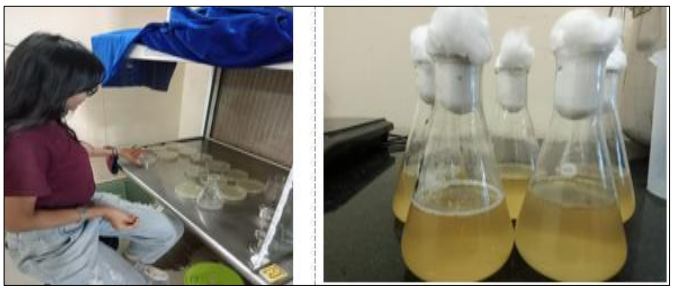

Fig 3: Measurement of microbial population of cut gerbera flowers

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