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Locally available preservatives effect on postharvest quality and extension of vase life of cut chrysanthemum (*Dendranthema grandiflora*) cv. Arctic queen

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Abstract
The present investigation was carried out in the Department of Floriculture and landscape Architecture laboratory, College of Horticulture, Rajendranagar, Hyderabad during the year 2017-2018, 2018-2019. The main objective of the investigation was to find out the efficacy of different locally available preservatives on physical (fresh weight of flower, diameter of flower, percent neck bending, vase life and over all acceptability of flowers), physiological (water uptake, transpiration loss of water, fresh weight change, relative water content, chlorophyll content in calyx), biochemical parameters (TSS of petals, pH of vase solution, optical density of vase solution, electrolyte leakage) in two days interval during the vase life period of cut chrysanthemums. The experiment was laid out in completely randomized design with factorial concept and replicated thrice. Among the different locally available preservatives studied, pongamia seed oil 1 percent was very effective in increasing the fresh weight of flower (6.70 g), flower diameter (6.3 cm), water uptake (19.18 g), fresh weight change (95.68 g), relative water content (83.94%), cholrophyll content of calyx (34.91), Total soluble solids (5.8 degrees), over all acceptability of flowers (9.46), vase life of chrysanthemum cut flowers (15.93 days). It has led to lowest electrolyte leakage (76.21%) and transpiration loss of water (11.36 g/f).

Keywords: Triclosan, TCS, determination, detection, sensor

Introduction

Chrysanthemum (*Dendranthema grandiflora*) is popularly known as "Queen of East". Chrysanthemum occupies prime position next to rose in the international market. It belongs to the family Asteraceae and has been commonly grown in garden for more than 2500 years (Bose *et al*., 2003) [1]. Chrysanthemum is an important ornamental which is grown for its excellent beauty, different colours, shapes and economic value. It is grown commercially for cut flowers for vases, for loose flowers, for interior decoration at ceremonies and for pot mums. The flower head of chrysanthemum is composed of many florets borne on a receptacle. The outer ray florets are pistillate and infertile where as inner disc florets are inconspicuous and fertile. In large-flowered chrysanthemum varieties, the ray florets are prominent where as the inner disc florets are either absent or very inconspicuous. Wide variations occur in chrysanthemum cultivars with respect to growth habit, size, colour and shape of the bloom. Chrysanthemum is a qualitative short day plant and requires 13.5 h of photoperiod for initiation and 14.5 h of light for development of flower buds (Kofranek, 1992) [2].

Cut flowers of chrysanthemum are widely used in two types namely, standard (one flower on the stem) and spray (multiple flowers on the stem). In general, it requires high light intensity and plants grown under reduced light become taller have strong stem and larger leaves. Now a day, cut flowers occupy an important position in the local and foreign markets because of their importance as a source of national income. Senescence of flowers in different flower species is genetically controlled and also by the environmental factors during development (Teixeira da Silva, 2003 and Bhattacharjee and De, 2006) [3, 4].

The senescence of petals marks the termination of longevity of the flower and is generally marked by wilting of petals, abscission of petals or the whole flower. Senescence can broadly be defined as the combination of events that leads to death of cells, tissues or organs. The gaseous hormone ethylene, a naturally occurring plant hormone, enhances senescence and shortens the vase life of many flowers (Reid and Wu 1992) [5]. Short postharvest life is one of the most important problems of the cut flowers. Using vase preservatives in vase solutions is one of the most common methods for prolonging cut flowers vase life. Once flowers are purchased, the longer they last in a vase or flower arrangement, the purchasers would enjoy the aesthetic qualities, fragrance and fresh appearance of cut flowers and the consumers will be encouraged to buy them again. Hence, there is a dire need to explore possibilities of extending the vase life by using different preservatives, antioxidants, antitransparents, essential oils, vase chemicals, and preservative solutions (Tsegaw *et al*., 2011) [6].

To preserve the best quality of cut flower after harvest and to make them resistant to fluctuations in environment conditions, treatments like conditioning or hardening, impregnation, pulsing, loading, bud opening, holding treatment and packing are recommended, which may be applied to the flowers during the marketing chain from growers to wholesalers, retail florists and final consumers. Floral preservatives affect the quality of the flower by prolonging their vase life thereby increasing the flower size and maintaining the colour of flower and the leaves. Postharvest management is one of the major problem in flower marketing. Nearly, 30-40 per cent losses of flowers occur due to improper postharvest handling during entire market chain (Singh and Tiwari, 2002) [7]. Further, lack of standardized postharvest technologies, storage facilities, inadequate and under developed transportation system, absence of scientific and modern harvesting technology, lack of infrastructural facilities, lack of standardized chemicals and packing method are the main reasons which deteriorate the quality of flower and enhance the postharvest losses of flower. The postharvest pulsing, which is a short term pre-shipment treatment with high concentration of sucrose in combination with various other chemicals, affect postharvest vase life of cut flowers. Pulsing of flowers before storage helps to improve post-storage life of cut flowers (Arora and Singh, 2002) [8]. Floral preservatives are chemical formulations used to improve size, colour and vase life of cut flowers. Many floral preservatives contain germicides, ethylene synthesis inhibitors, growth regulators, essential oils, anti oxidants, anti transparents, some mineral compounds and carbohydrates that are essential to extend the vase life of cut flowers (Mutui, 2002) [9]. Several attempts have been made to prolong the vase life of cut flowers by using commercial floral preservatives viz. Florissant, Chrysal, Bloomlife, Petallife, Roselife etc. However, these preservatives are costly and out of reach for most of small scale cut flower growers, hence the use of locally available floral preservatives viz. sugar, vinegar, lime juice, neem oil and pongamia oil which would be handy and cheaper.

Use of some chemical compounds as preservatives for maintaining the longevity of cut flowers are very expensive and most harmful for human, causing irritation to skin, eyes and respiratory tract *etc*. To counter these problems, the locally available preservatives are organic natural substances are safe and environmental friendly due to their strong antimicrobial properties against some pathogens. (Lambert *et al.*, 2001 and Mihajilov-Krstev *et al.*, 2010) [10, 11].

Keeping quality is an important parameter for evaluation of cut flower quality, for both domestic and export markets. Addition of preservatives to the holding solution is recommended to prolong the vase life of cut flowers. To minimise the postharvest losses the flowers should be supplied with flower food. An effective flower food should contain all the basic components to extend life of flowers. Sugars act as the source of food for the flowers during the vase life. The biocides that are included in floral preservatives maintain clarity in the solution and prevent blockage of xylem elements by microorganisms. (Pun *et al*., 2005) [12].

Appropriate methods such as subjecting the flowers for floral treatments along with adopting packaging technology offers better possibilities for long term storage and provide solution for storing flowers during unforeseen circumstances such as delay in marketing of flowers and to improve the postharvest shelf life. But the postharvest behaviour and lasting quality of flower species and cultivars vary considerably. It is important to ensure that the cut flowers lost with longest vase life. Various factors influence the postharvest performance and vase life of cut flowers (Ichimura *et al*., 2002) [13]. Once the flower gets detached from their mother plant also it continues to perform the activities like respiration, transpiration etc and their ageing process accelerates. To delay their ageing process and to subsequently increase their vase life, postharvest treatment is crucial (Tsegaw *et al.,* 2011) [14].

Materials and Methods

The present investigation was carried out in the Department of Floriculture and Landscape Architecture Laboratory, College of Horticulture, Rajendranagar, Hyderabad during the year 2017-18 and 2018-19. The experimental location, Rajendranagar is situated at an altitude of 542.3 m above mean sea level on 78° 29' East longitude and 17°19' North latitude. Flowers of chrysanthemum (*Dendranthema grandiflora* L.) cultivar 'Arctic queen' were obtained from commercial farm located at Ravulavari palle village in Chevella mandal, 35 km away from the College of Horticulture, Rajendranagar. Chrysanthemum cv. Arctic queen is a spray type. The plant is multi-headed producing white colour flowers with green centre making the flower elegant and attractive, which fetches it a good market price. The cut stem length is about 65 -70 cm. Flower head is 6 to 8 cm diameter. The cut stem is hard and strong. The flowers were continuously held in the treatment solutions till the end of the vase life period and vase life was defined as days from time of immersion in the test solution to the loss of ornamental value, like stem bending, blackening, wilting and abscission of petals. The experiments were repeated twice for confirmation of the results. Standardized water reduced experimental variability (Rule *et al.,* 1986) [15]. Therefore, all the solutions were prepared with distilled water and only freshly prepared solutions were used in the experimentation. In each glass bottle five flowers were placed and were considered as one replication. Destructive samples were placed separately for analysis work. The individual flower stems were placed randomly in the 500 ml glass bottles containing 250 ml of aqueous test solutions of different treatments. The weight of each container and the test solution with and without flower stems were recorded once in two days, while recording weights recutting of the floral stems (about 0.5 cm) was done under water. Vase life and other visual observations of the flowers were recorded daily. T1 - Vinegar 2%, T2 - Vinegar 4%, T3 - Lime juice 2% T4 - Lime juice 4%, T5- Pongamia seed oil 1%, T6- Pongamia seed oil 2%, T7- Neem seed oil 1%, T8- Neem seed oil 2%, T9- Control (Distilled water). Vinegar 2% and 4%, lime juice 2% and 4% solutions were prepared by dissolving 20 ml, 40 ml respectively each in one litre of distilled water. Pongamia oil 1% and 2%, neem extract 1% and 2% solutions were prepared by dissolving 10 ml and 20 ml in ethyl alcohol and Triton x

100 was added to dissolve the oil completely and then final volume was made to one litre by adding distilled water.

Results and Discussion

The cut flowers held in different locally available preservatives differed significantly for flower weight of chrysanthemum (Table 1). The treatment T_5 (6.70 g) has recorded maximum flower weight which was on par with T_6 (6.43 g) and T_8 (6.46 g).The lowest flower weight was recorded with T_9 (5.98 g) which was on par with T_3 (5.82 g) and all other treatments recorded the intermediate values of flower weight. There were significant differences in flower fresh weight of cut chrysanthemum during different days of vase life period, the flower weight had increased from day 2 (6.67 g) to day 4 (7.08 g) and flower weight decreased from day 6(6.29 g) to day 10 (4.89 g). Significantly highest flower weight was recorded on day 4 (7.08 g) and significantly lowest flower weight was recorded on day 10 (4.89 g).The interaction effect between days and treatments on flowers fresh weight in locally available preservative solutions was found to be significant in cut chrysanthemum cv. Arcticqueen. On day 2, the treatment T_5 (7.15 g) recorded the highest flower fresh weight which was on par with T_8 (6.96 g),T_6 (6.84 g) and T_2 (6.70 g) and the lowest flower weight was recorded with T_1 (6.28 g) which was on par with T_7 (6.51 g) and T_9 (6.61 g). On day 4, the treatment T_5 (7.50 g) recorded the highest flower fresh weight which was on par with T_8 (7.26 g), T_6 (7.09 g) and T_9 (7.05 g) and the lowest flower fresh weight was recorded with treatment T_3 (6.87 g) and all other remaining treatments recorded the intermediate values for flower fresh weight of cut chrysanthemum cv. Arcticqueen. On day 6, the highest flower fresh weight was recorded with T_5 (6.86 g) which was on par with T_6 (6.55 g), T_1 (6.45 g), T_8 (6.57 g) and the lowest flower fresh weight was recorded with T_2 (5.69 g) which was on par with T_3 (5.92 g). On day 8, the highest flower fresh weight was recorded with T_5 (6.59 g) which was on par with T_6 (6.21 g) and T_8 (6.26 g) and the lowest flower weight was recorded with T_2 (4.90 g). On day 10, the highest flower weight was recorded with T_6 (5.44 g) which was on par with T_5 (5.38 g), T_7 (5.16 g), T_8 (5.24 g), T_1 (5.20 g) and the lowest flower fresh weight was recorded with T_9 (4.20 g) which was on par with T_2 (4.37 g), T_3 (4.22 g).The data confirms that pongamia seed oil at 1% recorded the highest fresh weight of flowers, might be due to more water uptake and more retention, also could be due to its antimicrobial property due to chemical constituents of pongamia seed oil which might have prevented the growth of microbes which in turn inhibited the plugging of water conducting tissues. Pulsing with sucrose acts as a respiratory substrate and also as an osmolite helps in maintenance of better water relations in cut chrysanthemum flower. The enhanced and continuous water uptake might be responsible for retardation of senescence of flowers (Chandrasekar and gopinath, 2004) [16]. Similar results were obtained by Sunanda (2007) [18] in cut carnation cv. Domingo and Prasanth (2006) [17] in cut gerbera flower.

Table 1: Effect of locally available preservatives on fresh weight (g) and flower diameter of cut chrysanthemum cv. Arcticqueen

Treatments	2nd day	4th	6th	8th day	10th	Mean	2nd day	4th	6th	8th day	10th	Mean
	Flower weight(gm)						Flower Diametre(cm)					
T1 - Vinegar 2%	6.28	6.89	6.45	5.83	5.20	6.13	6.28	6.89	6.45	5.83	5.20	6.13
T2 - Vinegar 4%	6.70	7.09	5.69	4.90	4.37	5.75	6.70	7.09	5.69	4.90	4.37	5.75
T3 - Lime juice 2%	6.60	6.87	5.92	5.47	4.22	5.82	6.60	6.87	5.92	5.47	4.22	5.82
T4 - Lime juice 4%	6.36	6.96	6.28	5.83	4.82	6.05	6.36	6.96	6.28	5.83	4.82	6.05
T5- Pongamia seed oil 1%	7.15	7.50	6.86	6.59	5.38	6.70	7.15	7.50	6.86	6.59	5.38	6.70
T6- Pongamia seed oil 2%	6.84	7.09	6.55	6.21	5.44	6.43	6.84	7.09	6.55	6.21	5.44	6.43
T7- Neem seed oil 1%	6.51	7.03	6.18	6.02	5.16	6.18	6.51	7.03	6.18	6.02	5.16	6.18
T8- Neem seed oil 2%	6.96	7.26	6.57	6.26	5.24	6.46	6.96	7.26	6.57	6.26	5.24	6.46
T9- Control (Distilled water)	6.61	7.05	6.17	5.90	4.20	5.98	6.61	7.05	6.17	5.90	4.20	5.98
Mean	6.67	7.08	6.29	5.89	4.89		6.67	7.08	6.29	5.89	4.89	
	F test		Sem		CD (0.01)		F test		Sem		CD (0.01)	
Treatment	**		0.05		0.20		**		0.06		0.29	
Day	**		0.04		0.15		**		0.08		0.22	
TXD	**		0.12		0.45		**		0.18		0.49	

** Significant at ($P \leq 0.01$) * Significant at ($P \leq 0.05$) NS: Not significant.

The cut flowers held in different locally available preservatives differed significantly for flower diameter of cut chrysanthemum (Table 1). The treatment T_5 (6.3 cm) recorded the highest flower diameter and the lowest flower diameter was recorded with T_3 (5.5 cm) which was on par with T_1 (5.7 cm), T_4 (5.7 cm), T_7 (5.8 cm), T_9 (5.8 cm), T_6 (5.9 cm), T_2 (5.9 cm) and all other treatments recorded the intermediate values. There were significant differences in flower diameter of cut chrysanthemum during different days of vase life period. The flower diameter has decreased gradually from day 2 (6.6 cm) to day 10 (5.0 cm). The interaction values for days and treatments were also found to be significant for flower diameter of cut chrysanthemum cv. Articqueen. On day 2, the flower diameter was highest with treatment T_5 (6.8 cm) and there was no significance difference in flower diameter and all the remaining treatments are on par with T_5. On day 4, the highest flower diameter was recorded with T_5 (6.5 cm) which was on par with T_1 (6.3 cm), T_8 (6.4 cm) and the lowest flower diameter was recorded with the treatment T_3 (6.0 cm). On day 6, the highest flower diameter was recorded with the treatment T_2 (6.1 cm) and which was significantly highest over all other treatment and there was no significant difference with the remaining treatment except for T_3 (5.5 cm) which recorded the lowest flower diameter. On day 8, the highest flower diameter was recorded with treatment T_5 (6.1 cm) which was on par with T_2 (5.7 cm) and T_6 (5.7 cm), the lowest flower diameter was recorded with T_8 (4.7 cm) which was on par with T_3 (5.0 cm), T_1 (5.1 cm). On day 10, the highest flower diameter was recorded with T_5 (5.7 cm) which was on par with T_6 (5.3 cm) and lowest flower diameter was recorded with T_8 (4.5 cm) which was on par with T_3 (4.7 cm). The observations suggests that one percent pongamia seed oil recorded highest flower diameter might be due to pulsing of sucrose provided the food and antimicrobial activity of pongamia seed oil might have reduced the xylem blockage,

maintained continuous water flow which in turn maintained the flower diameter of cut chrysanthemum cv. Articqueen.
The cut flowers of chrysanthemum cv. Articqueen held in different locally available preservatives differed significantly for water uptake by the cut flowers (Table 2). The treatment T_5 (19.18 g/f) recorded the maximum water uptake which was on par with T_6 (18.83 g/f). The lowest water uptake by the cut chrysanthemum flowers was recorded with T_2 (13.96 g/f) which was on par with T_1 (14.04 g/f) and all other treatments recorded the intermediate results. There were significant differences in water uptake of cut chrysanthemum cv. Articqueen during different days of vase life period. The water uptake by cut chrysanthemum cv. Articqueen flowers increased from day 2 (18.82 g/f) to day 4 (20.60 g/f) then gradually water uptake decreased from day 6 (17.69 g/f) to day 10 (9.49 g/f) and the highest water uptake was noticed at day 4 (20.60 g/f) and lowest water uptake was noticed at day 10 (9.49 g/f). The interaction effect of water uptake of cut chrysanthemum cv. Articqueen between days and treatments was found to be significant. On day 2, significantly highest water uptake was recorded for treatment T_5 (21.61 g/f) which was on par with T_5 (21.25) and the lowest water uptake was recorded for treatment T_2 (16.36) was on par with T_1 (17.24 g/f). On day 4, the highest water uptake was recorded for treatment T_5 (23.46 g/f) which was on par with T_6 (23.24 g/f) and the lowest water uptake was recorded for treatment T_4 (18.42 g/f) which was on par with T_1 (19.29 g/f), T_2 (18.77) and T_3 (19.11 g/f). On day 6, the highest water uptake was recorded with the treatments T_5 (21.02 g/f) which was on par with T_6 (20.42 g/f) and the lowest water uptake was recorded with treatment T_1 (14.37 g/f) which was on par with T_2 (14.38 g/f). On day 8, the highest water uptake was recorded with the treatment T_5 (17.95 g/f) which was on par with T_6 (17.31 g/f) and the lowest water uptake was recorded with the treatment T_1 (11.36 g/f) which was on par with T_2 (11.73 g/f). On day 10, the highest water uptake was recorded with treatment T_6 (11.92 g/f) which was on par with T_5 (1.86 g/f) and the lowest water uptake was recorded with the treatment T_1 (7.97 g/f) which was on par with T_2 (8.56 g/f) and all other treatments under different locally available preservative solutions recorded intermediate values for water uptake by cut chrysanthemum flowers. The data reveals that one percent pongamia seed oil recorded highest water uptake of cut chrysanthemum flower stems might be due to its antimicrobial property which might have prevented growth of microbes which in turn inhibited the plugging of water conducting xylem tissues. The cut chrysanthemum flowers held in different locally available preservative solutions differed significantly for transpiration loss of water of flowers (Table 2). The treatment T_3 (13.06 g/f) recorded significantly highest TSS over other treatments, the lowest TSS was recorded for the treatment T_5 (11.36 g/f) which was on par with treatment T_6 (11.80 g/f) and all other remaining treatments recorded the intermediate values.

Table 2: Effect of locally available preservatives on water uptake (g/f) and transpiration loss of water of cut chrysanthemum cv. Arcticqueen

Treatments	2nd	4th	6th	8th	10th	Mean	2nd	4th	6th	8th	10th	Mean
T1 - Vinegar 2%	17.24	19.29	14.37	11.36	7.97	14.04	10.47	11.14	12.08	12.80	14.19	12.14
T2 - Vinegar 4%	16.36	18.77	14.38	11.73	8.56	13.96	10.25	11.26	12.29	12.97	13.88	12.13
T3 - Lime juice 2%	18.75	19.11	17.53	12.47	9.96	15.57	11.05	12.36	13.37	13.77	14.74	13.06
T4 - Lime juice 4%	17.99	18.42	17.90	14.55	9.71	15.71	10.78	11.44	12.27	13.50	14.19	12.44
T5- Pongamia seed oil 1%	21.61	23.46	21.02	17.95	11.86	19.18	10.42	10.91	11.39	11.91	12.19	11.36
T6- Pongamia seed oil 2%	21.25	23.24	20.42	17.31	11.92	18.83	10.67	11.62	11.69	12.10	12.91	11.80
T7- Neem seed oil 1%	19.25	21.33	18.51	16.20	8.64	16.79	10.67	11.35	12.64	13.39	13.85	12.38
T8- Neem seed oil 2%	18.77	20.97	17.68	15.56	7.98	16.19	10.81	10.87	12.66	13.32	13.79	12.29
T9- Control (Distilled water)	18.14	20.83	17.41	15.64	8.80	16.16	10.19	11.08	12.29	13.46	14.41	12.28
Mean	18.82	20.60	17.69	14.75	9.49		10.59	11.34	12.30	13.08	13.74	
	F test		Sem		CD(0.01)		F test		Sem		CD (0.01)	
Treatment	**		0.17		0.65		**		0.14		0.54	
Day	**		0.13		0.48		**		0.11		0.40	
TXD	**		0.39		1.45		**		0.32		0.91	

** Significant at ($P \leq 0.01$) * Significant at ($P \leq 0.05$) NS: Not significant

There were significant differences in transpiration loss of water of cut chrysanthemum flowers during different days of vase life period. The transpiration loss of water of flowers gradually increased from day 2 (10.59 g/f) to day 10 (13.74 g/f).The interaction effect of transpiration loss of water of cut chrysanthemum cv. Articqueen between days and treatments was found to be significant. On day 2, the highest TLW was recorded with treatment T_3 (11.05 g/f). However there were no significant differences in treatments, the lowest TLW was recorded with T_9 (10.19 g/f). On day 4, the highest TLW was recorded with T_3 (12.36 g/f) which was on par with all other treatments and there was no significantly difference among the treatments. On day 6, the highest TLW was recorded with T_3 (13.37 g/f) which was on par with all other treatment except for treatment T_7 (12.64 g/f) and T_8 (12.66 g/f). On day 8, the highest TLW was also recorded with T_3 (13.77 g/f) which was on par with T_4 (13.50 g/f), T_2 (12.97 g/f), T_7 (13.39 g/f), T_8 (13.32 g/f), T_9 (13.46 g/f) and the lowest TLW was recorded with treatment T_5 (11.91 g/f) which was on par with T_6 (12.10 g/f). On day 10, the highest TLW was recorded with T_3 (14.74 g/f) which was on par with T_1 (14.19 g/f), T_2 (13.88 g/f), T_4 (14.19 g/f) and T_9 (14.41 g/f) and the lowest TLW was recorded with T_5 (12.19 g/f) which was on par with T_6 (12.91 g/f). The observation from the Table confirms that pongamia seed oil at 1% has recorded lowest TLW because of its better water relations due to preservative characteristics and antimicrobial property. The adequate and controlled TLW might have contributed to the retardation of senescence process and enhanced vase life of cut flowers (Chandrasekhar and Gopinath, 2004) [19]. Similar results were obtained by Sundnda (2007) [18] in cut carration cv. Domingo, Bhanumurthy (2013) in cut gerbera cv. Savannah.
The cut chrysanthemum flowers held in different preservative solutions differed significantly for fresh weight change of flowers (Table 3). The treatment T5 (95.68 g) recorded the highest FWC which was on par with T_6 (93.19 g), T_7 (92.62 g). The lowest FWC was recorded with T_2 (80.07 g) which was on par with T_1 (81.47 g) and all other treatments recorded the intermediate values. There were significant differences in fresh weight change of cut chrysanthemum flowers during

different days of vase life period. FWC of cut chrysanthemum flowers decreased gradually from day 2 (97.28 g) to day10 (75.14 g). The interaction values for days and treatments were also found to be significant for FWC of cut chrysanthemum cv. Articqueen. On day 2, the highest FWC was recorded with treatment T_5 (106.21 g) which was on par with T_6 (104.01 g), T_7 (100.98 g), T_8 (101.49 g), the lowest FWC was recorded with T_2 (91.29 g) which was on par with T_1 (91.52 g), T_3 (96.82 g), T_4 (90.16 g), T_9 (93.05 g). On day 4, the highest FWC was observed with treatment T_5 (100.40 g) which was on par with T_6 (99.83 g), T_7 (97.12 g), T_8 (98.29 g), T_3 (93.77 g) and the lowest FWC was recorded with treatment T_2 (87.45 g) which was on par with T_1 (88.05 g), T_3 (93.77 g), T_4 (88.28 g), T_9 (89.08 g). On day 6, the highest FWC was recorded with T_5 (99.84 g) which was on par with T_6 (96.45 g), T_7 (94.52 g), T_8 (95.38 g). On day 8, the highest FWC was recorded with T_5 (89.59 g) which was on par with all other treatments except for T_1 (74.72 g), T_2 (71.53 g), T_3 (76.70 g). On day 10, the highest FWC was recorded with T_5 (82.33 g) followed by T_7 (81.61 g), the lowest FWC was recorded by T_2 (64.33 g). The data suggests that pongamia seed oil at 1% recorded maximum fresh weight change might be due to better water relations which probably maintained by preventing xylem occlusion due to antimicrobial property of pongamia extract and sucrose as a source of energy might not allowed for slump in fresh weight (Chandrasekhar and gopinath, 2004 [16] in cut carnation). Similar results were obtained by Sunanda (2007) [18] in cut caration cv. Domingo, Bhanumurthy (2013) in cut gerbera cv. Savannah.

The cut chrysanthemum flowers treated with different locally available solutions differed significantly for relative water content of petals (Table 3). The highest RWC was recorded with the treatment T_5 (83.94%) which was on par with T_6 (83.27%) and T_7 (82.61%). The significantly lowest RWC was recorded with the treatment T_4 (77.67%) and all other remaining treatments recorded the intermediate values. There was significant difference in RWC of cut chrysanthemum during different days of vase life period. The RWC has decreased from day 2 (87.31%) to day 10 (76.23%). The interaction effect on RWC of petals of chrysanthemum flowers between days and treatment was found to be significant in cut chrysanthemum cv. Articqueen. On day 2, significantly highest RWC was recorded with treatment T_5 (90.48%) and which was on par with T_6 (89.97%), T_7 (90.13%), T_8 (89.09%), the lowest RWC was recorded with treatment T_4 (82.64%). On day 4, the significantly highest RWC was recorded with treatment T_5 (86.66%), which was on par with T_6 (85.22%) and T_7 (85.65%), the lowest RWC was recorded with treatment T_3 (80.02%) which was on par with T_4 (80.91%). On day 6, the highest RWC was recorded with T_5 (85.31%), which was on par with T_1 (82.89%), T_2 (82.20%), T_6 (82.60%), the lowest RWC of petals was recorded with T_4 (77.71%) which was on par with T_3 (79.18%). On day 8, the highest RWC of petals was recorded with T_6 (80.29%) and the lowest RWC of petals was recorded with T_1 (77.03%) which was on par with T_3 (77.53%), T_2 (79.52%). On day10, the highest RWC was recorded with the treatment T_6 (78.28%) which was on par with T_5 (77.15%), T_7 (76.67%), T_1 (76.24%), T_9 (76.91%), the lowest RWC of petals was recorded with T_4 (71.88%) which was on par with T_2 (72.29%) and all other remaining treatments recorded the intermediate values. In the present studies the data confirm that Pongamia seed oil at 1% has recorded highest RWC of flower petals, which were pulsed in sucrose 10% solution may be attributed to available respiratory substrate, sucrose which is responsible for maintenance of water balance in cut flowers by maintaining osmotic concentration there by reducing water loss (Halery, Mayak 1978) [20] which further increased the longevity of flower (Marouskg, 1971) [21].

Table 3: Effect of locally available preservatives on fresh weight change (g) and relative water content of cut chrysanthemum cv. Arcticqueen

Treatments	2nd	4th	6th	8th	10th	Mean	2nd	4th	6th	8th	10th	Mean
T1 - Vinegar 2%	91.52	88.05	85.56	74.72	67.50	81.47	85.23	84.54	82.89	77.03	76.24	81.18
T2 - Vinegar 4%	91.29	87.45	85.77	71.53	64.33	80.07	85.23	83.03	82.20	79.52	72.29	80.45
T3 - Lime juice 2%	96.82	93.77	91.65	76.70	69.51	85.69	87.11	80.02	79.18	77.53	75.39	79.85
T4 - Lime juice 4%	90.16	88.28	87.80	82.49	77.03	85.15	82.64	80.91	77.71	75.19	71.88	77.67
T5- Pongamia seed oil 1%	106.21	100.40	99.84	89.59	82.33	95.68	90.48	86.66	85.31	80.07	77.15	83.94
T6- Pongamia seed oil 2%	104.01	99.83	96.45	86.44	79.19	93.19	89.97	85.22	82.60	80.29	78.28	83.27
T7- Neem seed oil 1%	100.98	97.12	94.52	88.87	81.61	92.62	90.13	85.65	81.53	79.07	76.67	82.61
T8- Neem seed oil 2%	101.49	98.29	95.38	83.06	75.83	90.81	89.09	85.00	81.20	78.93	75.99	82.04
T9- Control (Distilled water)	93.05	89.08	86.05	81.01	78.89	85.61	85.95	84.54	81.89	79.03	76.91	81.66
Mean	97.28	93.59	91.45	81.60	75.14		87.31	84.09	81.61	78.52	76.23	
	F test		Sem		CD(0.01)		F test		Sem		CD (0.01)	
Treatment	**		0.02		0.06		**		0.41		1.54	
Day	**		0.01		0.05		**		0.31		1.15	
TXD	**		0.04		0.14		*		0.92		2.59	

** Significant at ($P \leq 0.01$) * Significant at ($P \leq 0.05$) NS: Not significant

The cut flowers held in different locally available preservative solutions differed significantly for chlorophyll content of calyx of chrysanthemum (Table 4). The treatment T_5 (45.21) recorded the highest chlorophyll content which was on par with T_6 (43.15). The lowest chlorophyll content of calyx was recorded with treatment T_9 (27.33) and all other remaining treatments recorded the intermediate values. There were significant differences in chlorophyll content of calyx of cut chrysanthemum flowers during different days of vase life period. The chlorophyll content was decreased from day 2 (50.66) to day 10 (27.56). The highest chlorophyll content of calyx was recorded of day 2 (50.66). The interaction effect between days and treatments on chlorophyll content of calyx of flowers held in different preservative solutions also differed significantly in cut chrysanthemum cv. Articqueen. On day 2, the highest chlorophyll content of calyx was recorded with treatment T_3 (64.21) which was on par with T_5 (56.87) and T_6 (55.15), the lowest chlorophyll content of calyx was recorded with treatment T_9 (38.25). On day 4, the highest chlorophyll content was recorded with T_5 (51.55) which was on par with T_3 (47.37), T_6 (48.29), the lowest chlorophyll content was recorded with T_9 (30.84) which was on par with T_2 (31.88). On day 6, the highest chlorophyll content was recorded with the treatment T_5 (43.79) which was on par with T_6 (40.43), T_7 (39.54), the lowest chlorophyll content was recorded with the treatment T_9 (23.67) which was on par with T_2 (28.69). On day 8, the highest chlorophyll content was recorded with T_5 (38.90) which was on par with T_6 (37.39), T_4 (35.17) T_7 (34.17), T_8 (34.84), the lowest chlorophyll content was recorded with T_9 (23.73) which was on par with T_1 (26.11), T_2 (26.14). On day 10, the highest chlorophyll content was recorded with T_5 (34.91) which was on par with T_6 (34.53), T_7 (33.40), T_8 (30.73), T_4 (32.40). The lowest chlorophyll content was recorded with T_3 (17.50), T_2 (20.11), T_9 (20.18) and the all other remaining treatments recorded intermediate values for chlorophyll content of calyx of cut chrysanthemum cv. Articqueen. The observations confirm that chlorophyll content of calyx of cut chrysanthemum cv. Articqueen decrease gradually with duration of vase life among all the treatments. Pongamia seed oil 1% recorded the highest chlorophyll content of calyx in cut chrysanthemum flowers. The decrease of chlorophyll in calyx might be due to destruction chlorophyll with days of vase life.

Table 4: Effect of locally available preservatives on chlorophyll content of calyx and TSS of cut chrysanthemum cv. Arcticqueen

Treatments	2nd	4th	6th	8th	10th	Mean	2nd	4th	6th	8th	10th	Mean
T1 - Vinegar 2%	51.70	36.55	30.29	26.11	24.30	33.79	3.4	4.2	4.5	6.2	6.8	5.0
T2 - Vinegar 4%	47.54	31.88	28.69	26.14	20.11	30.87	3.6	4.0	4.3	6.8	6.2	5.0
T3 - Lime juice 2%	64.21	47.37	37.07	30.24	17.50	39.28	2.9	4.1	4.1	5.3	5.7	4.4
T4 - Lime juice 4%	46.62	42.35	37.87	35.17	32.40	38.88	2.8	2.9	3.8	6.0	5.7	4.2
T5- Pongamia seed oil 1%	56.87	51.55	43.79	38.90	34.91	45.21	3.7	5.0	5.3	7.0	7.9	5.8
T6- Pongamia seed oil 2%	55.15	48.29	40.43	37.39	34.53	43.15	2.6	5.0	5.4	6.9	7.8	5.5
T7- Neem seed oil 1%	47.62	42.68	39.54	34.17	33.40	39.48	3.5	4.5	5.0	6.6	7.5	5.4
T8- Neem seed oil 2%	47.96	41.68	36.87	34.84	30.73	38.42	3.3	4.3	5.1	7.0	6.8	5.3
T9- Control (Distilled water)	38.25	30.84	23.67	23.73	20.18	27.33	4.0	4.3	5.1	6.5	6.5	5.3
Mean	50.66	41.47	35.36	31.85	27.56		3.2	4.2	4.6	6.5	6.8	
	F test		Sem		CD (0.01)		F test		Sem		CD (0.01)	
Treatment	**		0.61		2.27		**		0.06		0.21	
Day	**		0.45		1.69		**		0.04		0.16	
TXD	**		1.36		5.07		**		0.13		0.48	

** Significant at ($P\leq0.01$) * Significant at ($P\leq0.05$) NS: Not significant

The cut chrysanthemum flowers under different treatments differed significantly on TSS (Table 4). The treatment T_5 recorded significantly highest TSS (5.8). The lowest TSS value was recorded with the treatment T_4 (4.2) which were on par with T_3 (4.4). All other remaining treatments recorded the intermediate values. There were significant differences in flower TSS of cut chrysanthemum during different days of vase life period. The flower TSS has increased from day 2 (3.2) to day 10 (6.8). Highest TSS was recorded on day 10 (6.8).The interaction effect between days and treatments was found to be significant for TSS of cut chrysanthemum flowers kept in different locally available preservative solutions. On day 2, the highest TSS was recorded with treatment T_9 (4.0) which was on par with T_2 (3.6), T_5 (3.7) and T_7 (3.5), the lowest TSS was recorded with treatment T_6 (2.6) which was on par with T_3 (2.9) and T_4 (2.8). On day 4, the highest TSS was recorded with treatment T_5 (5.0) and T_6 (5.0) which was on par with T_7 (4.5) and the lowest TSS was recorded with T_4 (2.9). On day 6, the highest TSS was recorded with T_6 (5.4) which was on par with T_7 (5.0), T_8 (5.1) and T_9 (5.1), the lowest TSS was recorded with T_4 (3.8) which was on par with T_3 (4.1). On day 8, the highest TSS was recorded with T_8 (7.0), T_5 (7.0) which was on par with T_2 (6.8), T_6 (6.9), T_7 (6.6), the lowest TSS was recorded with T_3 (5.3). On day 10, the highest TSS was recorded with T_5 (7.9) which was on par with T_6 (7.8), the lowest TSS was recorded with T_3 (5.7), T_4 (5.7) and all other remaining treatments recorded the intermediate values. The observations indicates highest TSS of flower petals increased with days of storage which might be due to pre pulsing with sucrose before holding treatment in different locally available preservative solutions might have helped in increasing the concentration of glucose, fructose in flower petals. With days of vase life, the increase in TSS might be due to decrease of water content of flower petals leads to increased concentration of total sugar. The cut chrysanthemum flowers differed significantly on pH of vase solution (Table 5). Significantly highest pH was recorded with T_7 (5.67) which was on par with T_8 (5.64), T_5 (5.63) and the lowest pH was recorded with T_4 (3.52) and all other remaining treatments recorded the intermediate values of pH of vase solution. There were significant differences have been observed for pH of vase solution of cut chrysanthemum flowers with duration of days. The pH values gradually increased from day 2 (4.46) to day 10 (5.20). The interaction effect between days and treatment on pH of vase solution of cut chrysanthemum flower was also found to be significant. On day 2, the highest pH was recorded with T_9 (6.49) which was significantly highest over other treatments followed by T_8 (5.03), T_7 (4.85), T_6 (4.73) and the lowest pH was recorded with T_4 (3.32) which was on par with T_3 (3.36). On day 4, the highest pH was recorded with T_9 (6.25) followed by T_8 (5.48), T_7 (5.40), T_5 (5.45) and the lowest pH was recorded with T_4 (3.38). On day 6, the highest pH was recorded with T_9 (6.09) followed by T_7 (5.78), T_6 (5.66), T_8 (5.65) and the lowest pH was recorded with T_4 (3.59). On day 8, the highest pH was recorded with T_5 (6.16), followed by T_7 (6.08), T_6 (5.93), T_9 (5.91) and the lowest pH was recorded with T_4 (3.65). On day 10, the highest pH was recorded with T_7 (6.22), followed by T_5 (6.21) T_8 (6.17) and the lowest pH was recorded with T_4 (3.69). The observations shows that treatment with 4 percent lime juice recorded the lowest pH that might be due to the acidic nature of lime juice as it contains citric acid which led to lowering of pH of vase solution.

Table 5: Effect of locally available preservatives on electrolyte leakage and Ph of vase solution of cut chrysanthemum cv. Arcticqueen

Treatments	2nd	4th	6th	8th	10th	Mean	2nd	4th	6th	8th	10th	Mean
T1 - Vinegar 2%	78.79	83.61	87.90	89.51	93.79	86.72	4.03	4.17	4.36	4.32	4.58	4.29
T2 - Vinegar 4%	71.28	78.79	81.47	84.68	90.04	81.25	3.73	3.75	3.95	3.98	4.06	3.90
T3 - Lime juice 2%	69.14	74.50	80.40	85.76	91.11	80.18	3.36	3.72	3.80	3.97	4.07	3.78
T4 - Lime juice 4%	70.75	78.79	83.61	85.49	89.99	81.72	3.32	3.38	3.54	3.65	3.69	3.52
T5- Pongamia seed oil 1%	65.39	68.60	75.57	83.08	88.43	76.21	4.58	5.45	5.74	6.16	6.21	5.63
T6- Pongamia seed oil 2%	67.00	72.89	78.79	84.68	88.97	78.47	4.73	5.34	5.66	5.93	6.02	5.54
T7- Neem seed oil 1%	67.00	69.14	76.64	87.36	93.26	78.68	4.85	5.40	5.78	6.08	6.22	5.67
T8- Neem seed oil 2%	61.64	65.39	84.15	88.43	93.79	78.69	5.03	5.48	5.65	5.88	6.17	5.64
T9- Control (Distilled water)	70.75	75.73	80.57	83.66	87.58	79.66	6.49	6.25	6.09	5.91	5.79	6.11
Mean	69.08	74.16	81.01	85.85	90.78		4.46	4.77	4.95	5.10	5.20	
	F test		Sem		CD(0.01)		F test			Sem		CD (0.01)
Treatment	**		1.10		4.08		**			0.02		0.08
Day	**		0.82		3.04		**			0.02		0.06
TXD	*		2.45		6.89		**			0.05		0.19

** Significant at ($P \leq 0.01$) * Significant at ($P \leq 0.05$) NS: Not significant.

The cut chrysanthemum flowers under different treatments differed significantly for electrolyte leakage (Table 5). Significantly highest electrolyte leakage was recorded with treatment T_1 (86.27%) which was significantly highest over all other treatments, T_5 (76.21%) which recorded the lowest electrolyte leakage, and all other remaining treatments recorded the intermediate values. There were significant differences in electrolyte leakage during different days of vase life period of cut chrysanthemum flowers. The electrolyte leakage values gradually increased from day 2 (69.08%) day 10 (90.78%). The interaction effect on electrolyte leakage between days and treatments was also found to be significant. The treatment combination of day 2 and treatment T_2 (78.79%) recorded the highest electrolyte leakage which was on par with T_2 (71.28%) and the lowest electrolyte leakage has recorded with treatment T_8 (61.64%). On day 4, the highest electrolyte leakage was recorded with T_1 (83.61%) where as T_8 (65.39%) recorded significantly lowest electrolyte leakage. On day 6, T_1 (87.90%) recorded significantly highest electrolyte leakage which was on par with T_8 (84.15%), T_2 (81.47%), significantly lowest electrolyte leakage was observed with T_5 (75.57) which was on par with T_6 (78.79%), T_7 (76.74%). On day 8, the highest electrolyte leakage was recorded with T_1 (89.51%) which was significantly highest over all other treatments. On day 10, T_1 (93.79%), recorded the highest electrolyte leakage, the lowest electrolyte leakage was recorded with treatment T_5 (88.43%) which was on par with T_6 (88.9%).The observations indicates that pongamia seed oil 1% recorded lowest electrolyte leakage might be due to less water stress created in cut flowers stems due to low TLW might have caused because of good membrane integrity which led to lowest electrolyte leakage. A high-level of turgidity is necessary for development of good water relations and continuation of normal metabolite activities in the cut flower to extend the vase life (luo *et al.,* 2003, sunanda 2007) [18]. The vase life of cut chrysanthemum held in different locally available preservative solutions differed significantly with a highest vase life for T_5 (15.93 days) which was on par with T_6 (15.43 days) followed by T_8 (13.47 days), T_7 (13.33 days) and the lowest vase life was recorded with treatment T_9 (9.13 days) which was on par with treatment T_1 (9.33 days), T_2 (9.53 days) and all other remaining treatments recorded intermediate vase life (Table 6). The data confirm that pulsing with sucrose 10% and holding with pongamia seed oil 1% recorded highest vase life of cut chrysanthemum cv. Articqueen. A high level of turgidity is necessary for development of good water relations for continuation of normal metabolic activities in the cut flower to extend the vase life. Similar results were observed with Chandrashekar and Gopinath (2004) [19], Sundanda (2007) [18] in cut camation cv. Domingo which showed good water balance, good maintenance of fresh weight and longer vase life with treatment neem extract 2% followed by pongamia extract 2%. But in chrysanthemum cv. Articqueen the results showed good water uptake, cumulative transpirations loss, good fresh weight maintenance and longer vase life with pongamia seed oil 1%. The overall acceptability of flowers held in different locally available preservative solutions differed significantly. The highest overall acceptability of flowers was recorded with treatment T_5 (9.46 days) which was significantly superior over all other treatments and was on par with treatments T_6 (9.05 days) and T_7 (8.89 days). The lowest overall acceptability of flowers was recorded with treatment T_9 (7.76 days) which was on par with T_1 (7.81 days) (Table 6). The data revealed that the treatment with Pongamia seed oil 1% recorded highest overall acceptability of cut chrysanthemum cv.Articqueen due to good water uptake, lower transpiration loss of water, maintaining good water balance in cut flower.

Table 6: Effect of locally available preservatives on over all acceptability and vase life of flowers chrysanthemum

Treatments	Over all acceptability of flowers	Vase life
T1 - Vinegar 2%	7.81	9.33 d
T2 - Vinegar 4%	8.18	9.53 d
T3 - Lime juice 2%	7.77	10.43 c
T4 - Lime juice 4%	7.67	9.67 cd
T5- Pongamia seed oil 1%	9.46	15.93 a
T6- Pongamia seed oil 2%	9.05	15.43 a
T7- Neem seed oil 1%	8.89	13.33 b
T8- Neem seed oil 2%	8.46	13.47 b
T9- Control (Distilled water)	7.76	9.31 d
Mean	8.32	11.82
F test	**	**
Sem	0.07	0.18
CD(0.01)	0.20	0.78

** Significant at ($P \leq 0.01$) * Significant at ($P \leq 0.05$) NS: Not significant.

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