The Bioscan 14(3): 241-246, 2019
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.com

INVESTIGATION OF DIFFERENT CARBOHYDRATE SOLUTIONS ENHANCED THE VASE LIFE OF CUT CARNATION FLOWERS (*Dianthus caryophyllus* L.) CVS. MASTER AND YELLOW CANDY

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KEYWORDS
Sucrose
Common sugar
Palm sugar
Palm crystals

Received on :
25.03.2019

Accepted on :
11.07.2019

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ABSTRACT

The present investigation on the effect of different carbohydrate solutions on quality and vase life of cut carnation flowers (*Dianthus caryophyllus* L.) cvs. Master and Yellow Candy, was carried out during the years 2016-2017 at the laboratory of Department of Horticulture, Annamalai University. The different sources of carbohydrate such as sucrose, common sugar, palm sugar, palm crystals and karupatti each at 1, 3 and 5% was laid out in completely randomized design with 16 treatments including a control. The water, quality and vase life parameters were observed in both the cultivars. Holding of carnation flowers with sucrose 5% resulted in maximum CUW (23.86 and 22.49g flower-1), minimum CTLW (20.29 and 21.84g flower-1 respectively), maximum fresh weight (14.36 and 13.63g flower-1), highest diameter of the flower (7.70 cm and 7.44 cm), slowest stem strength (82.430 and 80.670) and with vase life of (5.87 and 5.76 days) as compared with (3.34 and 2.45 days) in control in both the cultivars. Among the different carbohydrates Sucrose 5% was found highly effective for longevity of carnation flowers.

INTRODUCTION

Carnation (*Dianthus caryophyllus* L.) or Clove pink, family Caryophyllaceae, is an important cut flower in the world. Carnation got the name Dianthus from two Greek Words "dios", referring to the God Zeus, and "anthos", meaning Flower. Carnation is thus known as the "The Flower of god". It is native to Mediterranean region and central Asia, but its exact range is unknown due to extensive cultivation for the last 2,000 years because of their beautiful flowers and intense fragrance. It is genetically a quantitative long day plant (Blake, 1955). Carnation is among the top cut flower around the world in flower trade market. It occupies the third place after Gladiolus and roses. Columbia is the largest carnation producer in the world. It is the national flower of Spain, Monoca, and Slovenia. The beauty of the flowers lies with the freshness of the flowers for longer time without losing its aesthetic value. All along the marketing channel, there is enormous loss in the value of cut flowers which could be 50 percent of the farm value (Bhattacharjee, 1999).

Carnation is a climacteric flower that is highly sensitive to ethylene (Pun *et al.*, 1999). Pulsing of flowers before storage helps to improve post storage life of cut flowers (Arora and Singh, 2002). All holding solutions must essentially contain components *viz*., sugar, chemicals and germicides. The sugars and chemicals provide a respiratory substrate, while the germicides control harmful bacteria and prevent plugging of the conducting tissue (Nair *et al.*, 2003). It is clear that sugars delayed ethylene production in carnation flowers (Pun and Ichimura, 2003; Hassan, 2005). However, there is a lack of understanding of the mechanism of sugar action. Sugars are the source of energy for respiration, which maintains turgidity, plays an important role in flower freshness. Sucrose treatment leads to an increase in the mechanical rigidity of the stem, which is due to cell wall thickening and lignifications of vascular tissues (Steinitz, 1983). The present investigation was undertaken to study the effects of different carbohydrates on water related attributes and quality and vase life of cut carnation flowers (*Dianthus caryophyllus* L.) cvs. Master and Yellow Candy.

MATERIALS AND METHODS

The experiment was carried out in the laboratory of Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalai Nagar during 2016-2017. The two 'standard' type cultivars of carnation *viz*., 'Master' (Red) and 'Yellow Candy' (Yellow) were brought from Gayathiri Farm, Hosur, Tamilnadu. The selected flowers were harvested at paint brush stage. The flowers were carefully brought to the laboratory without causing any damage and the stalks were cut to a uniform length of 30 cm and the basal two pairs of leaves were removed and they were kept in clean water. Practices such as removal of lower leaves, clearing the stalks and re-cutting the base before placing them in the preservative solution were essential (Lemper, 1981). It is generally, preferable to use distilled water as standardized water reduces experimental viability (Rule *et al.*, 1986). Experiment was done in completely randomized design. Vase solutions were freshly prepared at the beginning of experiments. A vase solutions contains the following treatments *viz*., T1 - Sucrose - 1%, T2 - Sucrose - 3%, T3 - Sucrose - 5%, T4 - Common sugar - 1%, T5 - Common sugar - 3%, T6 -Common sugar - 5%, T7 – Palm sugar - 1%, T8 - Palm sugar - 3%, T9 - Palm sugar - 5%, T10 - Palm crystals - 1%, T11 - Palm crystals - 3%, T12 - Palm crystals - 5%, T13 - Karupatti - 1%, T14 – Karupatti - 3%, T15 – Karupatti -5% and T16 – Control. Each flower was placed in a 500 ml bottle containing 250 ml of distilled water of different carbohydrate solutions. Double distilled water was used to minimize experiment error. Solutions were prepared as and when required and used in the experiment. Each treatment consisted of 3 (three) replications where 5 (five) flowers were used per replication. The flowers were held at 80 percent relative humidity in ambient room temperature under 40 W cool white fluorescent lights to maintain 12 hours of photoperiod. Observations were taken on the quality and vase life attributes *viz*., Cumulative uptake of water (CUW), Cumulative transpirational loss of water (CTLW), Water balance, Fresh weight of cut flower, Cumulative physiological loss in weight (CPLW), Stem strength, Diameter of the flower, Flower discoloration / fading, Freshness of flower, Total soluble solids (TSS), pH of vase solution and Vase life. The data were subjected to statistical analysis as per the procedure outlined by Panse and Sukhatme (1978) and the results were tested at 5 percent level of significance.

RESULTS AND DISCUSSION

The data recorded on cumulative uptake of water (CUW), cumulative transpirational loss of water (CTLW), water balance and cumulative physiological loss in weight (CPLW) of both the cultivars as influenced by carbohydrates at different concentrations are presented in Table 1. Significant differences were found in various concentration of carbohydrates in extending the vase life cut carnation flowers. The cut carnation Cvs. Master and Yellow Candy held in vase solution containing sucrose at 5% (T3) recorded the maximum cumulative uptake of water (23.86 g.flower-1 and 22.49 g.flower-1) and least was observed in control T16 (18.74 g.flower-1 and 17.85 g.flower-1). In both the cases, effect of sucrose to supply readymade carbon source which is easily assimilated by cut carnation to result in higher cumulative uptake of water. Hence, apart from different carbohydrates studied, optimum concentration of sucrose at 5% (T3) in vase solution acts as a source of food and improves cumulative uptake of water. Acock and Nichols (1979) obtained similar results when cut flowers of carnation held in sucrose solution, owing to creation of higher osmotic potential. Nano silver and sucrose has a positively influence on water uptake in another way besides an anti-bacterial effect in cut flowers leaves of Lilium (Vinodh *et al.*, 2013).

The cut carnation Cvs. Master and Yellow Candy held in vase solution containing sucrose at 5% (T3) recorded the minimum cumulative transpirational loss of water (20.29 g.flower-1 and 21.84 g.flower-1 respectively) and maximum water balance (+3.57 g.flower-1 and +0.65 g.flower-1 respectively), whereas control (T16) recorded maximum cumulative transpirational loss of water (23.15 g.flower-1 and 24.83 g.flower-1 respectively) and negative water balance (-4.41 g.flower-1 and -6.98 g.flower-1 respectively). In both the cases, higher concentration of sucrose might have acted to reduce the rate of respiration resulting in lower cumulative transpirational loss of water. Similarly, Kim and Suk (2002) have reported that minimum cumulative transpirational loss of water in cut roses was recorded against control, which supports the findings of the present study. Maximum water balance can be justified by considering above mentioned parameters such as cumulative uptake of water and cumulative transpirational loss of water

Table 1: Response of cut carnation to different carbohydrate solutions on water related attributes

Treatments	CUW (g.flower-1)		CTLW (g.flower 1)		Water balance (g.flower-1)		CPLW (%)	
	Cv. Master	Cv. Yellow Candy	Cv. Master	Cv. Yellow Candy	Cv. Master	Cv. Yellow Candy	Cv. Master	Cv. Yellow Candy
T1- Sucrose 1%	23.01	21.73	20.97	22.55	2.04	-0.82	23.69	26.4
T2-Sucrose 3%	22.73	21.26	20.83	22.87	1.9	-1.61	24.23	27.38
T3-Sucrose 5%	23.86	22.49	20.29	21.84	3.57	0.65	19.77	24.97
T4-Common sugar 1%	22.45	21.48	21.12	22.73	1.33	-1.25	25.51	27
T5- Common sugar 3%	23.28	21.97	20.56	22.2	2.72	-0.23	22.44	25.97
T6- Common sugar 5%	22.18	21	21.29	23.01	0.89	-2.01	26.82	27.82
T7- Palm sugar 1%	21.35	19.27	21.83	24.1	-0.48	-4.83	31.46	32.34
T8- Palm sugar 3%	20.22	20.79	22.47	23.16	-2.25	-2.37	38.23	28.33
T9- Palm sugar 5%	20.5	20.35	22.18	23.44	-1.68	-3.09	35.48	29.17
T10- Palm crystals 1%	19.93	18.72	22.65	24.4	-2.72	-5.68	39.87	34.44
T11- Palm crystals 3%	19.65	20.55	22.82	23.32	-3.17	-2.77	41.33	28.87
T12- Palm crystals 5%	19.36	18.98	22.98	24.26	-3.62	-5.28	43.06	33.53
T13- Karupatti 1%	21.9	18.44	21.47	24.68	0.43	-6.24	28.36	35.64
T14- Karupatti 3%	21.08	20.12	22.01	23.62	-0.93	-3.5	32.98	29.58
T15- Karupatti 5%	21.63	19.57	21.65	23.79	-0.02	-4.22	29.83	31.21
T16- Control	18.74	17.85	23.15	24.83	-4.41	-6.98	46.79	37.76
SED	0.25	0.24	0.11	0.14	-	-	-	-
CD(P=0.05)	0.51	0.5	0.24	0.3	-	-	-	-

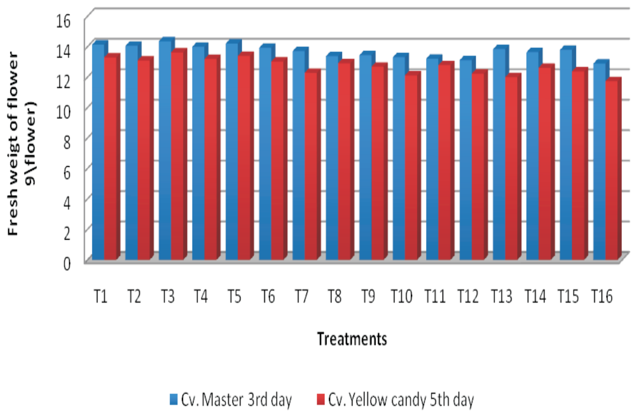

Figure 1: Response of cut carnation to different carbohydrate solutions on fresh weight of flower

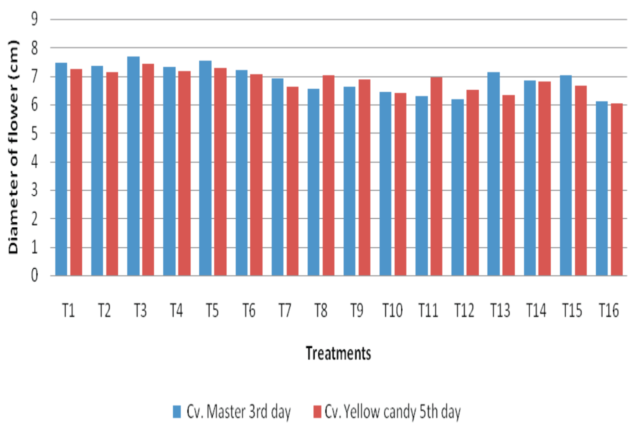

Figure 2 :Response of cut carnation to different carbohydrate solutions on diameter of flower

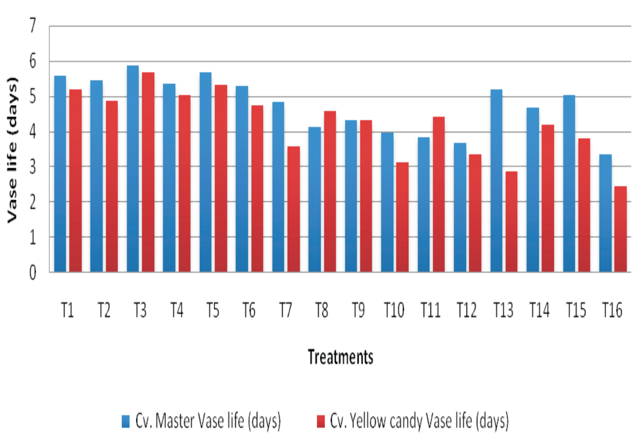

Figure 3: Response of cut carnation to different carbohydrate solutions on vase life of flower

values obtained could be treated as responsible for the maximum water balance. This was in accordance with the results obtained by Bhaskar *et al*. (2000) in cut tuberose Cv. Double.

Among the treatments sucrose at 5% (T3) excelled other treatments by recording the lowest cumulative physiological loss in weight of 19.77% and 24.97% respectively whereas highest CPLW of 46.79% and 37.76% was found in control (T16) of both Cvs. Master and Yellow candy. Steinitz (1982) reported that influence of sucrose on maintenance of mechanical rigidity of flowers by inducing cell wall thickness and lignification of vascular tissues which in total may reduce the physiological loss in water.

A perusal of data pertaining to fresh weight of carnation (Fig.1) of both Master and Yellow Candy cultivars held in vase solution sucrose at 5% (T3) recorded maximum fresh weight on 3rd day of 14.36 g.flower-1 and 13.63 g.flower-1 respectively followed by common sugar 3% and minimum was observed in control of 12.89 g.flower-1 and 11.74 g.flower-1. Here, the beneficial effect of sugar was attributed to supply of substrate for respiration, structural materials and osmoticum (Halevy and Mayak, 1979). This finding is in accordance with Pun *et al*. (2005), who reported that sucrose at 5% was found to be most effective concentration with respect to maintaining fresh weight of the spray carnation tested. Further, sucrose at 5% (T3) apparently inhibits climacteric ethylene production by inhibiting ACO activity. This effect may be indirect, by affecting gene expression and which supports the findings of the present study.

The data presented in Table 2 shows the results of stem strength, flower discoloration / fading and freshness of flower in both the cultivars was greatly influenced by different holding solutions. The slowest stem bending was found in cut carnation on 3rd and 5th day was highest in the treatment sucrose at 5% (T3) (82.430 and 80.670; 62.350 and 61.410) against the control (72.71 and 68.69; 43.610, 41.000 respectively). In this context, Sugar acted as source of carbohydrate and hypertonic solutions inside the cells allow water to enter the cells by osmosis and thus make them turgid. This turgidity gives the stem a rigid, upright structure. The results are in consonance with the findings Soad *et al*. (2011) in cut gerbera.

Cut carnation treated with T3 (sucrose at 5%) recorded maximum number of days taken for flower discoloration (5.95 days and 5.80 days) in the Cvs. Master and Yellow Candy whereas control observed with 3.06 days and 2.15 days. Addition of sugar to the vase solution counteracted the adverse effects of defoliation on petal color and overcome the increased bud blasting (Susan and Han, 2003) and external application of sugar reduces changes in petal colour (Kofranek and Halevy, 1976). With regard to freshness of flower, the vase solution containing sucrose at 5% (T3) recorded maximum days taken for flower shriveling (5.82 days and 5.72 days respectively) whereas control registered least days for shriveling with respect to both cultivars (3.47 days and 2.35 days respectively). The results are in confirmation with Khan *et al*. (2015) in gerbera.

Cut carnation Cvs. Master and Yellow Candy have clearly indicated that favourable effect of sucrose at 5% (T3) concentration was found to extent significant influence in enhancing the diameter of flower up to 3 days and then decreased (Fig.2). The greatest diameter (7.30 cm and 7.44 cm) was exhibited on 3rd day whereas lowest diameter was exhibited by control (6.12 cm and 6.05 cm respectively. In this study, we found that increases in diameter during initial period and then decreases during later days. Further, the lowest diameter of cut carnations obtained in control may be due to exhaustion of metabolities in the flowers nor vase solution led to failure of complete opening of cut flowers. Sucrose can act

Table 2: Response of cut carnation to different carbohydrate solutions on quality related attributes

Treatments	Stem Strength (degrees)				Flower discoloration (days)		Freshness of flower (days)	
	Cv. Master		Cv. Yellow Candy		Cv. Master	Cv. Yellow Candy	Cv. Master	Cv. Yellow Candy
	3rd day	5th day	3rd day	5th day				
T1- Sucrose 1%	80.78	59.47	78.77	58.11	5.47	5.32	5.51	5.22
T2-Sucrose 3%	80.24	58.5	77.52	55.31	5.29	4.77	5.46	4.71
T3-Sucrose 5%	82.43	62.35	80.67	61.41	5.95	5.8	5.82	5.72
T4-Common sugar 1%	79.68	57.52	78.17	56.61	5.16	4.97	5.36	5.05
T5- Common sugar 3%	81.33	60.43	79.4	59.31	5.64	5.45	5.66	5.38
T6- Common sugar 5%	79.15	56.46	76.91	54.08	5	4.6	5.24	4.51
T7- Palm sugar 1%	77.62	53.45	72.33	45.85	4.63	3.31	4.88	3.16
T8- Palm sugar 3%	75.3	49.49	76.27	52.83	3.97	4.44	4.41	4.32
T9- Palm sugar 5%	75.91	50.58	75.04	50.44	4.16	4.12	4.51	3.89
T10- Palm crystals 1%	74.77	48.3	70.82	43.76	3.8	2.75	4.3	2.89
T11- Palm crystals 3%	74.24	47.13	75.64	51.67	3.61	4.25	3.96	4.11
T12- Palm crystals 5%	73.74	45.91	71.58	44.79	3.41	3	3.81	3.02
T13- Karupatti 1%	78.64	55.45	70.05	42.68	4.86	2.45	5.15	2.74
T14- Karupatti 3%	77.05	52.54	74.38	49.21	4.48	3.99	4.74	3.71
T15- Karupatti 5%	78.14	54.37	73.07	47.11	4.74	3.63	5.03	3.33
T16- Control	72.71	43.61	68.69	41	3.06	2.15	3.47	2.35
SED	0.5	0.91	0.61	0.98	0.14	0.15	0.12	0.14
CD(P=0.05)	1.02	1.87	1.25	2	0.29	0.31	0.26	0.3

Table 3: Response of cut carnation to different carbohydrate solutions on TSS and pH of vase solution

Treatments	TSS (0Brix)				pH of vase solution			
	Cv. Master		Cv. Yellow Candy		Cv. Master		Cv. Yellow Candy	
	3rd day	5th day	3rd day	5th day	3rd day	5th day	3rd day	5th day
T1- Sucrose 1%	10.92	7.33	10.04	6.89	4.5	5.38	4.77	5.81
T2-Sucrose 3%	10.83	7.23	9.88	6.69	4.31	5	5.12	5.94
T3-Sucrose 5%	11.2	7.7	10.31	7.2	3.53	5.27	3.95	5.48
T4-Common sugar 1%	10.73	7.14	9.98	6.8	4.92	5.6	4.6	5.76
T5- Common sugar 3%	11	7.45	10.11	6.99	3.93	5.15	4.3	5.63
T6- Common sugar 5%	10.6	7.04	9.81	6.61	4.75	5.47	4.93	5.88
T7- Palm sugar 1%	10.27	6.65	9.08	5.88	5.74	6.03	6.69	6.63
T8- Palm sugar 3%	9.89	6	9.7	6.49	6.46	6.37	5.44	6.13
T9- Palm sugar 5%	9.97	6.18	9.51	6.31	5.95	6.1	5.82	6.29
T10- Palm crystals 1%	9.79	5.9	8.88	5.67	6.31	6.25	7.08	6.78
T11- Palm crystals 3%	9.68	5.77	9.61	6.38	6.85	6.56	5.26	6.06
T12- Palm crystals 5%	9.59	5.6	8.96	5.78	6.67	6.47	6.47	6.54
T13- Karupatti 1%	10.46	6.9	8.76	5.53	5.31	5.87	6.88	6.71
T14- Karupatti 3%	10.18	6.48	9.46	6.18	5.54	5.98	5.59	6.18
T15- Karupatti 5%	10.34	6.78	9.21	5.93	5.1	5.74	6.02	6.39
T16- Control	9.43	5.44	8.55	5.26	7.05	6.63	7.24	6.83
SED	0.07	0.1	0.06	0.09	0.16	0.06	0.14	0.05
CD(P=0.05)	0.16	0.22	0.14	0.19	0.33	0.13	0.3	0.12

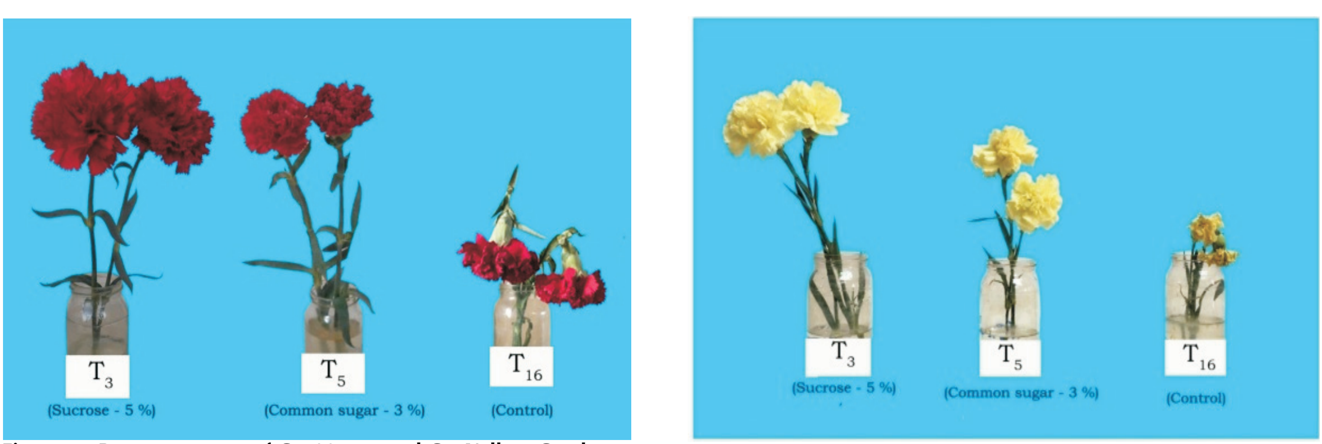

Figure 4 : Best treatments of Cv. Master and Cv. Yellow Candy

as a source of nutrition for tissues approaching carbohydrate starvation, flower opening and subsequent water relations suggested by (Kuiper *et al.*, 1995). The results are in consonance with the findings obtained by (Sharada, 1998).

It is evident from interaction between different concentration of carbohydrate solutions (Table 3) revealed the total soluble solids (TSS) and pH of vase solutions. Highest level of total soluble solids (TSS) were observed in treatment T3 (sucrose at 5%) in cultivar Master on 3rd day (11.20 0brix) and then decreased on 5th day (7.70 0brix), against the control (9.43 and 5.44 respectively) on 3rd and 5th day. The similar trend was found in cultivar Yellow Candy. These levels decreased as the flower progressed towards senescence which could be correlated with gradually reducing levels of stored sugars. That is the flower at advanced wilting stage and flower showing complete senescence, respectively. This relationship is well known and proved by Kumar and Singh (2004) in tuberose. On further confirmation, during senescence, sucrose is transferred from sink to various sources as senescence progresses (Van Doorn, 2004).

The interaction effect of carbohydrate solutions and both the cultivars was found that lower pH was recorded on the 3-----rd day (3.53 and 3.95) in the treatment T3 (sucrose at 5%) and then gradually increased on 5th day (5.27 and 5.48). Highest pH was recorded in control at the end of vase life period. This change in pH may be due to specific interaction of vase solution with inherent transport physiology and metabolism of cut flowers. On other hand, bacterial population rapidly developed at pH range between 4.0 and 7.0 in the cut surface and also inside the xylem conducts (Van Doorn *et al.*, 1991), it supports the usefulness as found in the present study.

One of the effective parameter on vase life with regard to them the effect of different carbohydrates on vase life enhancement, the treatment containing sucrose at 5% (T3) significantly influenced and improved vase life of cut carnation Cvs. Master and Yellow Candy (5.87 days and 5.67 days respectively) against all other treatments tested in the experiment (Fig.3). The results are in conformation with Ichimura *et al.* (2005), pointed out that antioxidant and ethylene action inhibition effects of sucrose might lead the cut flowers to inhibit longer vase life. Asrar (2012) revealed that sucrose is most commonly used floral preservative in order to prolong vase life of cut flowers among all the available sugars.

It is concluded that, sucrose has played major role to enhance the quality and vase life of both cultivars Master and Yellow Candy in cut carnation. Apart from sucrose, other carbohydrates utilized in the experiment *viz.*, common sugar, palm crystals, palm sugar and karupatti has conclusively revealed its effect and closely associated with each other's in deciding the quality and extending vase life over the control but optimum concentration or higher sugar content i.e sucrose at 5% showed marked effect on overall performance as well as enhancement of vase life (Fig.4). Hence, it has been fixed that to carry forward the research with best performing carbohydrate in combination with different chemicals in future.

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