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Original Research Article

Extending the Storage-Life and Shelf-Life of a Rose Flowers Cv. 'Dutch' Post-Harvest Using Chemical Compounds and Cold Storage (Ecofrost)

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ABSTRACT

Uniform and healthy Rose cut-flowers of cv. 'Dutch' were used for this study in August, 2016. The flowers were harvested at 7.00 AM at the bud opened stage, transported for 1.30 hours by an air-conditioned car to the Agricultural Research Laboratory of Ecofrost Technologies Pvt. Ltd., Pune and immediately prepared for post-harvest treatment and storage. The four holding solution treatments viz., control (tap water) + normal room conditions (T_1), control (tap water) + stored inside cold storage of Ecofrost (4°C and 93% RH) (T_2), Sucrose (7%) + stored inside cold storage of Ecofrost (4°C and 93% RH) (T_3), Sucrose (7%) + Citric acid (0.5%) + Aluminium Sulphate (0.5%) + stored inside cold storage of Ecofrost (4°C and 93% RH) (T_4) were replicated four times. The results showed that keeping flowers at cold storage (Ecofrost) in a holding solution of 7% Sucrose + 0.5% Citric acid + 0.5% Aluminium Sulphate recorded the highest level of bud tightness, storage-life (days) and minimum petal-curling, head-bending, petal-drop.

Keywords: *Rose, Dutch, Storage, Ecofrost, Shelf-life.*

INTRODUCTION

Rose (*Rosa indica* L.) is one of the most important ornamental plants in the world. The cut-rose flower industry is also the most important aspect of the rose culture industry. [1] Rose is, according to fossil evidence, 35 million years old. In nature, the genus *Rosa* has some 150 species spread throughout the Northern Hemisphere, from Alaska to Mexico including northern Africa. Garden cultivation of roses began some 5,000 years ago, probably in China. [2] The vase-life of cut-rose flowers is comparatively short. Depending on the species, longevity of flowers varies and the functional life of petals is ended by flower closure, wilting or abscission or changing color of petals prior to wilting or abscission. [3]

Many researches show that one of the most important causes of shortening of vase-life in roses is the blockage of xylem vessels which constricts water supply to flowers. Occlusions are thought to develop due to various factors such as bacteria, air emboli and physiological responses of the stem to cutting. [4] Adding citric acid improves flower longevity by decreasing the pH of the solution and controlling microbial functions in a vase solution of rose-cut flowers. [5] It is also reported that antimicrobial compounds increase flower longevity. [6]

Additionally, Aluminium Sulphate with sugar had the lowest weight loss and highest enhancing flower diameter of cut rose-flowers. Cut rose-flowers are often harvested in commercial maturity or bud stage so flowers need a large amount of soluble carbohydrates for opening. Treatment with sugars, such as sucrose and glucose in combination with some germicides was shown to extend the vase-life of many cut-flowers and can affect ethylene production and regulation of sugars accumulation in floral organs. [4] It is reported that Aluminium Sulphate extended the vase-life and improved water relation and postharvest quality of cut rose flowers due to its antimicrobial effect. [7] Treatment with sucrose promoted the unfolding of petals, and suppressed the decrease in fresh weight of cut-flowers.

Rose is a popular crop for both domestic and commercial cut-flowers purpose. Generally they are harvested and cut when in bud, and held in refrigerated conditions until ready for display at their point of sale. Most water supplies are alkaline and can reduce the life of cut-flowers. Production of field grown cut-flowers has become quite popular in recent years. The variety of flowers grown has also increased dramatically. While, production of high-quality flowers is important, it is equally critical to handle the flowers properly after they are harvested from the field. There are reports that improper post-harvest handling accounts to 20 to 30% of cut-flower loss during marketing. [8,9]

To achieve savings, the storage-life of stored rose flowers cv. 'Dutch' must be extended by a farmer by providing the consumer with equivalent flower quality. The aim of the study was to determine the effectiveness of certain chemicals in combinations with other approaches, *i.e.* cold storage on the post-harvest quality of an important flower crop in connection with the cut flowers' longevity and quality.

MATERIALS AND METHODS

The present study was carried out in the Agricultural Laboratory of Ecofrost Technologies Pvt. Ltd. Tathawade, Pune (MH), India during the month of August, 2016. Rose (*Rosa indica* L.) cv. "Dutch" (dark red) flowers were cut in the early morning on 12thAugust, 2016. The Dutch flowers were harvested at the commercial harvesting stage. Stems of cut-flowers transported to the research laboratory were trimmed to 65cm. Almost all the flowers had the same stem length (65cm). Cut-flowers were put immediately in lukewarm water. Flowers were subjected to cold storage treatments (T_2, T_3 and T_4 at 4°C and 93% relative humidity) and control treatment to room temperature (T_1). Each treatment had four replications and ten flowers per replication. After 10 days storage, the flowers were stored at normal room conditions for post-storage shelf life observation up to 3.5 days. The data for respective parameters like bud-tightness, head-bending, petal-curling, petal-fall and storage-life (days) were measured as per the schedule of observations. At intervals of every two days, the Rose stems were cut using sharp, clean cutters, and the rose stems were cut at a 45° angle so that they do not sit flat at the bottom of the vase (bucket), which could impede water intake. The cut roses were put in a bucket of lukewarm water. Then, the rose stems were re-cut under the water to eliminate air bubbles, which can decrease flower life and can also cause re-mature wilting of the rose bloom. Precautions were taken to remove the foliage below the water line help to prevent the upsurge of bacteria.

The 10 flowers of Rose cv. 'Dutch' per replicate were treated with the desired concentration of chemicals. The period of initial vase solution treatments was 2hrs at normal room temperature. The treated soaked flower stems were then transferred to cold storage conditions (4°C and 93% relative humidity) while dipped in the same solution.

A quality parameter like bud-tightness was evaluated by rating scales. Bud-tightness was evaluated on a 5-point scale, where 1 = 0 to 20%, 2= 21 to 40%, 3= 41 to 60%, 4 = 61 to 80% and 5 = 81 to 100%.

Storage-life was recorded by the number of days between the time of harvest and the end of longevity that occurs in ways such as bending the floral axis just below the flower head (bent-neck), flower closure, wilting or abscission, changing colour of petals. The experiments were replicated four times with completely randomised block designs.

OBSERVATIONS RECORDED

The observations regarding post-harvest parameters viz., bud-tightness, petal-drop, head-bending, petal-curling were recorded every day at 5.00 PM from 12^{th} to 25^{th} August, 2016. The storage-life of rose flowers cv. 'Dutch' was recorded at each treatment replication and cumulative data was subjected to statistical analysis.

STATISTICAL ANALYSIS

Recorded data was statistically analysed (ANOVA analysis) using the software WASP, (developed at ICAR Research Complex for Goa, India). Mean comparisons were performed using the LSD test to determine whether the difference between the variables was significant at P <0.05. [10]

RESULTS & DISCUSSION

The parameters like bud-tightness (Table 1), petal-curling (Table 2), head-bending (Table 3), petal-drop (Table 4), storage-life and post-storage shelf life (Table 5); (Photo 1 & Photo 2) were studied.

The results (Table 1) found that slightly opened Rose flowers cv. 'Dutch' held in a solution like Sucrose (7%) + Citric acid (0.5%) + Aluminium Sulphate (0.5%) for the first 2 hours at room conditions and then transferred to Ecofrost (4°C and 93% RH) (T_4) had positive effects followed by treatment T_3 (Sucrose 7%) + stored at Ecofrost (4°C and 93% RH) (T_3) for particularly maximum bud-tightness percentages than all remaining treatments at the end of experiment. Highly loose flowers were observed in treatment T_1 (control).

The data (Table 2) showed that treatment T_4 significantly maintained lower petal-curling inside cold storage conditions as compared to treatment T_1 (control) in RT (room temperature). Petal-dropping was first observed in treatment T_1 on 15^{th}, August 2016 at room temperature. Treatment T_4 had no petal drops observed inside cold room conditions for initial 9 days of storage from 12^{th} August to 21^{st}August, 2016.

Significant difference was obtained for head-bending (P <0.05). In general, 'Dutch' had negligible head-bending observed in Aluminium Sulphate and Sucrose treatment than tap water treatment. The maximum head bending in tap water treatment was observed and minimum head bending was observed when they were treated with Citric acid + Aluminium Sulphate + Sucrose. Head bending was not observed during the experimental period in cold storage. 100% head bending was observed in treatment (T_1) on 21^{st}August, 2016.

The first petal-drop was observed in T_1 on 19^{th} August 2016 whereas, no petal drop was observed when Rose flowers cv. 'Dutch' treated with 7% Sucrose + 0.5% Citric acid + 0.5% Aluminium Sulphate with tap water (Table 4).

There was a significant difference in rose cv. 'Dutch' flower storage life (P <0.05). The highest storage-life of Rose flowers cv. 'Dutch' was noticed in cold storage under treatment T_4, then followed by treatment like T_3 and a similar pattern was also observed during post-storage periods in T_3, T_2 and T_1. The lowest storage-life was observed in T_1, then followed by T_2.The longest storage life in 'Dutch' was observed when it was treated with 7% Sucrose + 0.5% Citric acid + 0.5% Aluminium Sulphate. The storage-life of 'Dutch' became short when it was treated with just tap water.

An acidifier like citric acid makes the pH of the water reach nearer to the acid pH functioning of the cell sap. Sucrose serves as a source of energy to make up for the loss of the functioning leaves and insures continued development and longevity of the flower. The treatment of cut-flowers with Sucrose is found to be beneficial in delaying senescence processes. Thus, treatment presumably allows the accumulation of adequate sugar in the leaves and stems during that time period to aid the development of flowers. These findings are in conformity with those. [8,9]

Table 1: Evaluations of bud-tightness of rose cv. 'Dutch' flower(s) (n=10) in normal room conditions and inside cold storage (Ecofrost).

Treat No.	12-Aug-16	13-Aug-16	14-Aug-16	15-Aug-16	16-Aug-16	17-Aug-16	18-Aug-16	19-Aug-16	20-Aug-16	21-Aug-16	22-Aug-16	23-Aug-16
	Normal room conditions (RT)											
T_1	5.00	4.75	3.50	3.00	2.75	2.00	1.00	1.00	1.00	1.00	1.00	1.00
	Cold Storage (Ecofrost Technologies Pvt. Ltd., Pune) (4°C and 93% Relative humidity)											RT
T_2	5.00	5.00	3.50	3.25	3.00	2.75	2.50	2.25	1.75	1.75	1.50	1.50
T_3	5.00	5.00	4.00	3.75b	3.50	3.00	3.00	3.00	2.50	2.50	2.50	2.50
T_4	5.00	5.00	4.50	4.25	4.00	4.00	3.75	3.50	3.50	3.00	2.50	2.50
CD @ 0.05	0.00	0.37	0.74	0.64	0.56	0.71	0.56	0.56	0.71	0.56	0.74	0.74
Significant	NS	**	**	**	**	**	**	**	**	**	**	**
Scale			1=0-20% (Tight)		2=21-40% (Tight)		3=41-60% (Tight)		4=61-80% (Tight)		5=81-100% (Tight)	
	NS = Non Significant		**= Highly Significant				RT- Normal storage conditions				n=10	

Table 2: Evaluations of petals curling observed in Rose Cv. 'Dutch' flower(s) (n=10) in normal room conditions (RT) and inside cold storage (Ecofrost).

Treat No.	12-Aug-16	13-Aug-16	14-Aug-16	15-Aug-16	16-Aug-16	17-Aug-16	18-Aug-16	19-Aug-16	20-Aug-16	21-Aug-16	22-Aug-16	23-Aug-16
	Normal room conditions (RT)											
T_1	0.00	0.00	0.00	1.00	2.00	2.75	4.25	5.50	6.75	9.25	9.75	10.00
	Cold Storage (Ecofrost Technologies Pvt. Ltd., Pune) (4°C and 93% Relative humidity)											RT
T_2	0.00	0.00	0.00	0.00	0.00	0.00	0.75	2.25	4.75	6.25	7.50	7.75
T_3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	3.00	4.00	4.75	5.00
T_4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.75	2.00
CD @ 0.05	0.00	0.00	0.00	0.60	0.60	1.52	1.31	1.02	1.00	1.56	1.30	1.26
Significant	-	-	-	**	**	**	**	**	**	**	**	**
	NS = Non Significant		**= Highly Significant		RT-Normal storage conditions				n=10			

Table 3: Evaluations of head-bending observed in rose cv.'Dutch' flower(s) (n=10) in normal room conditions (RT) and inside cold storage (Ecofrost).

Treat No.	12-Aug-16	13-Aug-16	14-Aug-16	15-Aug-16	16-Aug-16	17-Aug-16	18-Aug-16	19-Aug-16	20-Aug-16	21-Aug-16	22-Aug-16	23-Aug-16
	Normal storage conditions											
T_1	-	-	-	-	-	1.50	2.25	7.25	9.25	10.00	10.00	10.00
	Cold Storage (Ecofrost Technologies Pvt. Ltd., Pune) (4°C and 93% Relative humidity)											RT
T_2	-	-	-	-	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00
T_3	-	-	-	-	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00
T_4	-	-	-	-	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CD @ 0.05	-	-	-	-	-	0.43	0.37	0.71	0.71	0.00	0.00	0.00
Significant						**	**	**	**	-	-	-
	NS = Non Significant		**= Highly Significant		RT-Room Temperature				n=10			

Table 4: Evaluations of first petal-drop observed in rose cv.'Dutch' flower(s) (n=10) in normal room conditions and inside cold storage (Ecofrost).

Treat No.	12-Aug-16	13-Aug-16	14-Aug-16	15-Aug-16	16-Aug-16	17-Aug-16	18-Aug-16	19-Aug-16	20-Aug-16	21-Aug-16	22-Aug-16	23-Aug-16
	Normal room conditions (RT)											
T_1	-	-	-	-	-	-	-	1.00	2.00	4.00	5.00	5.00
	Cold Storage (Ecofrost Technologies Pvt. Ltd., Pune) (4°C and 93% Relative humidity)											RT
T_2	-	-	-	-	-	-	-	0.00	0.00	0.00	1.00	2.00
T_3	-	-	-	-	-	-		0.00	0.00	0.00	0.00	0.00
T_4	-	-	-	-	-	-	-	0.00	0.00	0.00	0.00	0.00
CD @ 0.05	-	-	-	-	-	-	-	0.43	0.60	0.43	0.56	0.80
Significant	-	-	-	-	-	-	-	**	**	**	**	**
	NS = Non Significant		**= Highly Significant		RT=Room Temperature				n=10			

Table 5: Evaluations of the storage-life of rose cv. 'Dutch' flower(s) (n=10) in normal room conditions and inside cold storage (4°C and 93% RH) (Ecofrost).

Treat No.	Treatment Details	No of days of storage-life of rose Cv. 'Dutch'
T_1	Control (tap water) + normal room conditions or RT	3.50 (Normal room conditions)
T_2	Control (tap water) + stored inside cold storage of Ecofrost	12.33 (Cold storage of Ecofrost + RT)
T_3	Sucrose (7%) + stored inside cold storage of Ecofrost	13.67 (Cold storage of Ecofrost + RT)
T_4	Sucrose (7%) + Citric Acid 0.5% + Aluminium Sulphate 0.5% + stored inside cold room of Ecofrost	14.17 (Cold storage of Ecofrost + RT)
CD @ 0.05		1.15
Significant		**
	**= Highly Significant, RT= Room Temperature	n=10

T_1=Control (Tap water) + RT

T_2= Control (Tap water) + stored inside cold storage of Ecofrost.

T_3= Sucrose (7%) + stored inside of cold storage of Ecofrost.

T_4= Sucrose (7%) + Citric Acid 0.5% + Aluminium Sulphate 0.5% + stored inside cold storage of Ecofrost.

Photo 1. General view of treatments (After 10 Days)

Photo 2. General view of treatments like T_1, T_2, T_3 and T_4 (After 12 days)

CONCLUSION

In conclusion, it is reported that chemical compounds can extend the storage and post-storage shelf-life of rose cut-flowers and improve the post-harvest quality of the flowers, its effects vary depending upon the chemicals. In this study, T_4 (Sucrose 7% + Citric acid 0.5% + Aluminium Sulphate 0.5%) was the best treatment for cultivar 'Dutch' for maximum bud tightness, storage-life and minimum petal curling, head bending, and petal drop.

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