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EVALUATION OF SOME DIFFERENT WRAPPING AND POSTHARVEST TREATMENTS ON CHRYSANTHEMUM CUT FLOWERS

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ABSTRACT: *The experimental trial was consummated throughout two successive seasons (2006 and 2007) at Ornamental Plants Research and Landscape Dep., Hort. Res. Inst, Giza. It was intended to find out the individual as well as the combined effect of different wrapping materials (polyethylene, cellophane, Butter paper and Kraft), type of cut and pulsing solutions on the vase life and keeping quality of cut flowers of spray Chrysanthemum (Dendranthema grandiflorum, Ramat.) cv. Discovery was investigated. Thus, a set of flowers were recut at the stem ends under water and the other set was recut in air prior to placement in the pulsing solution, packing in the various wrapping materials and then dry cold storage at 5 °C for 4 days were experimented. The results emphasized that, the flowers recut under water improved water uptake and increased the percentage of flower weight. This indicated that the rehydration ability of flower was restored, when the stem ends were recut under water. As for the recutting in air, the air that is aspired directly after cutting (into the opened xylem) was solely responsible for the blockage that developed after cutting and may impede water uptake. Cut flowers pulsed in the preservative solution of sucrose (3%) + 8- Hydroxyquinoline citrate (250 mg/l) + silver nitrate (25 mg/l) + citric acid (150 mg/l) for 18 h had the longest vase life, the least fresh weight loss percentage in cold storage and increased the percentage of flower opening. The best packaging treatments were wrapping in polyethylene or cellophane which raised CO2 concentration around flowers. Thus, reducing respiration rate and maintaining flowers quality. Finally, it could be concluded that the best treatment was the recutting of the stem ends under water before pulsing in a preservative solution (sucrose (3%) + 8- Hydroxyquinoline citrate (250 mg/l) + silver nitrate (25 mg/l) + citric acid (150 mg/l) and then wrapping in polyethylene or cellophane which prolonged vase life and reduced the depletion of sugars content in petals. This is due to the reduction in respiration and metabolic rate of the flowers.*

Key Words: *Chrysanthemum cut flowers, postharvest treatments, vase life.*

INTRODUCTION

Cut flowers of Chrysanthemum (*Dendranthema grandiflorum*, Ramat) cv. Discovery belongs to family Compositae. Chrysanthemum has been popular all over the world.

The storage research of floricultural plants and cut flowers started to go parallel with the expansion of the floricultural industry. It was also directed toward the increasing problems of appropriate preservation of large volumes of flowers products, especially for their transport, export and distribution to the consumers.

Different kinds of films to wrap flowers such as polyethylene, cellophane, kraft and butter paper were used to avoid desiccation (water loss) and to modify atmosphere around flowers. Packages are barrier to movement of water vapor and aid in the maintenance of high relative humidity (RH) and turger of commodity. Maintenance of very high RH can encourage moisture condition on the commodity, creating conditions favorable for pathogen growth (Ben – Yehoshua, 1985). The film can also be impregnated with fungicide or ethylene absorbers and reduced O_2 or elevated CO_2 can delay fruits ripening, reduced respiration and ethylene production rates (Kader, 1986 and Kader *et al.*, 1988).

Recutting of 2.5 cm of the rose stem end under water, prior to placement in the bacterial suspension, no cavitations were observed in stems. This indicated that cavitations started with the air in xylem conduits that were opened by cutting. It is concluded that a bacterial occlusion resulted in a high rate of cavitations with air bubbles. These bubbles may further impede water uptake (Bleeksma *et al.,* 2003).

Cut flowers kept in a holding solution of benzyladenine (BA) (0.025 mM) + silver thiosulfate (4.0 mM) + 8-Hydroxyquinoline (250 ppm) + sucrose (5%) had the longest vase life, the greatest flower diameter and the lowest fresh weight loss in storage (Anju *et al.*, 1999).

The purpose of this works is to improve the keeping quality of chrysanthemum cut flowers during transit periods, with low costs, to meet any disadvantageous causes during transportation and to increase marketing periods by using different kinds of films to wrap flowers such as polyethylene, cellophane, butter paper and kraft paper during cold storage period with applying different kinds of type of stems recuting such as in air and under water. Enhancement of opening and vase life of flowers by using a pulsing solution was also taken in consideration.

MATERIALS AND METHODS

The experimental trial research was carried out at Ornamental Plant Research and Landscape Department, Horticultural Research Institute; Giza, Egypt throughout two successive seasons (2006 and 2007). Chrysanthemum (*Dendranthema grandiflorum*, Ramat) cv. Discovery flowers were purchased from a commercial farm. Flowers were harvested when the majority of flowers were opened in the early morning and transported to the laboratory during 1 hr. Precooling of flowers was performed by placing them in ice cold water for 3 hr which removes the field heat of the cut flowers and enhances the vase life and flower quality. The flowers were selected for uniformity in terms of development; the stems were trimmed to an equal length (60 cm).

Flowers were divided into two groups: the first group (120 flowers), stem ends were re-cut, (remove about ٢,٥cm) in air whereas the second one (120 flowers) were re-cut, (remove about ٢,٥cm) under distilled water. Each group was then divided into two sub group:

A- Flowers were pulsed in distilled water (D.W) for 18 hr.
B- Flowers were pulsed in a preservative solution containing sucrose (3%) + 8- Hydroxyquinoline citrate (250 mg/l) + silver nitrate ($AgNO_3$) (25 mg/l) + citric acid (150 mg/l) (pH= 3.60) for 18 hr.

Each four sub groups were redivided again into five bunches:

1- Flowers without wrapping.
2- Flowers wrapped in kraft paper (84 x 115 cm).
3- Flowers wrapped in butter paper (70 x 92 cm).
4- Flowers wrapped in cellophane (58 x 83 cm).
5- Flowers wrapped in polyethylene films of 30 micron thickness (50x 81cm).

After that the flowers were packed in carton boxes (102 x 50 x 30 cm) to be stored at 5°C for 4 days. At the end of the storage period, packaging of flowers were removed and the stem end was recut , each four flowers were placed in a vase (500 ml) containing 300 ml distilled water (D.W) under lab conditions of 22 ± 2°C, 50 – 60 % RH and 24 hr lighted with fluorescent lamps to complete shelf life.

Measurements:

1- Weight loss percentage was recorded after the end of storage period.
2- Flower vase life (days) was considered ended when flowers began wilting.
3- Flower quality: it was evaluated immediately after flower removal from the cold storage. Evaluation was based on damage in the flower such as wilting symptoms by using a scale ranging from 1 to 5, where 1= bad; 2= moderate; 3= good; 4= very good; 5= excellent.
4- Flower opening percentage.
5- Water uptake (cm^3).
6- Flower fresh weight percentage increase.
7- Carbon dioxide (CO_2) percentage was measured from the tightly sealed wrapping materials bags after the end of storage period. One milliliter aliquots of the air was withdrawn, and the CO_2 content of the air was determined using a gas chromatograph coupled with methanizer and fitted with a flame ionization detector (Shimadzu GC. 9 A, Kyoto, Japan).

8- Total soluble sugars content was determined in fresh petals after the end of storage period, colorimetrically according to the methods described by Dubois *et al*., (1956).

The layout of the experiment was completely randomized design in factorial experiment containing 20 treatments (5 wrapping materials x 2 type of cut x 2 pulsing solutions). Each treatment was repeated three times, each replicate contained of 4 flowers i.e. 12 flowers in each treatment.

Statistical analysis:

All data were subjected to statistical analysis according to the procedure reported by Snedecor and Cochran (1982) and means were compared by New Less Significant Difference (L.S.D) test at the 5% level of probability in the two seasons.

RESULTS AND DISCUSSION

Effect of wrapping materials, type of cut, pulsing solutions and their interaction on Chrysanthemum (*Dendranthema grandiflorum*, Ramat) cv. Discovery after dry cold storage for 4 days at 5°C:

1- The percentage of flower weight loss during dry cold storage at 5°C for 4 days: Data in Table (1) show that using different kinds of wrapping materials to wrap flowers before dry cold storage reduced the percentage of weight loss compared to flowers without wrapping in both seasons.

Negligible differences were recorded in weight loss resulted from flowers wrapped in polyethylene and cellophane also, the weight loss was very little in both seasons. Flowers wrapped in butter paper, kraft paper and those without any wrapping increased in weight loss compared to polyethylene and cellophane. Prevention of water loss has been one of the major effective factors of packaging fresh flowers in different wrapping materials. Low temperature combined with wrapping materials were found to keep moisture content in most cases, this may be due to that flowers soon build up a beneficial high relative humidity within such bags. In the same time, flowers without wrapping increased water loss with cold storage, indicating that water was evaporated.

Wrapping in polyethylene and cellophane during cold storage reduced water loss and retained high humidity around flowers. These results were in agreement with those of El- Saka (1996,a) on some cut flowers who found that wrapping in polyethylene or Fresha. Pac or cellophane with flowers shipping in foam boxes containing dry ice reduced water loss. Concerning the effect of type of cut, it can be observed from Table (1) that the recutting under water from the stems of Chrysanthemum was more effective on reducing the percentage of flower weigh loss than recutting in air in the two seasons. Data in Table (1) show also that the flowers pulsed in the preservative solution gave lower percentage of flower weight loss than those pulsed in distilled water in both seasons.

Flowers recut under water x pulsed in preservative solution x wrapped in polyethylene or cellophane bags had the least percentage of weight loss in both seasons. These were in agreement with the findings of Lefevre *et al.*, (1991) who found that packing materials such as polyethylene cardboard lined with polyethylene or wax paper provide effective barriers to moisture loss.

Table (1): Effect of wrapping materials, type of cut, pulsing solutions and their interaction on flower weight loss percentage of Chrysanthemum (*Dendranthema grandiflorum*, Ramat) cv. Discovery cut flowers after dry cold storage for 4 days at 5°C during 2006 and 2007.

Treatment	Pulsing solution									
	Distilled water		Preservative solution			Distilled water		Preservative solution		
	Cut type									
Wrapping material	2006					2007				
	In air	Under water	In air	Under water	Mean	In air	Under water	In air	Under water	Mean
Without wrapping	1.70	1.47	1.30	1.20	1.42	1.65	1.42	1.25	1.17	1.37
Kraft	1.20	0.92	0.68	0.52	0.83	1.15	0.89	0.62	0.48	0.79
Butter paper	1.06	0.82	0.60	0.46	0.74	1.03	0.76	0.58	0.40	0.69
Cellophane	0.44	0.35	0.21	0.13	0.28	0.40	0.28	0.19	0.10	0.24
Polyethylene	0.40	0.33	0.17	0.10	0.25	0.37	0.25	0.15	0.07	0.21
Mean of pulsing solution	0.80		0.54			0.82		0.50		
Mean of cut type	In air		Under water			In air		Under water		
	0.78		0.63			0.74		0.58		

2- Flower vase life (day): The results in Tables (2and 3) show that there were significant increases in vase life of flowers packed in both polyethylene and cellophane compared to the other treatments in both seasons. These results are in agreement with those of Palanikumar *et al.*, (2000) who found that the cut rose flowers packed in polyethylene registered the maximum vase life. El- Saka (1996, a) on some cut flowers added that flowers packaging in polyethylene, Fresha- Pac and cellophane significantly increased the vase life compared to the other treatments.

Regarding the effect of cut type, it can be concluded from Tables (2and 3) that recutting under water from the stems gave significantly higher values of vase life (10.85 and 10.72 days in the first and second seasons, respectively) than those of recutting in air (9.39 and 9.36 days in both seasons, respectively).

Pulsing the flowers in preservative solution significantly enhanced the vase life of cut flowers over those pulsed in distilled water in both seasons. Concerning data of the interactions (wrapping materials x type of cut x pulsing solutions) shown in Tables (2and 3) reveal that the highest values of vase life were found with either polyethylene or cellophane bags x recutting under water x pulsing in a preservative solution compared to the other treatments in both seasons. These results coincided with the findings of Anju *et al.*, (1999) on *Chrysanthemum morifolium* mentioned that cut flowers kept in a pulsing solution of benzyadenine (0.025 mM) + silver thiosulfate (0.4 mM) + 8- Hydroxyquinoline (250 ppm) + sucrose (5%) and wrapping in cellophane had the longest vase life.

Table (2): Effect of wrapping materials, type of cut, pulsing solutions and their interaction on flower vase life (day) of Chrysanthemum (*Dendranthema grandiflorum*, Ramat) cv. Discovery after dry cold storage for 4 days at 5°C during (2006).

Treatment	Pulsing solution						Mean		
	Distilled water			Preservative solution					
Wrapping material	Cut type								
	In air	Under water	Mean (AXC)	In air	Under water	Mean (AXC)	(A)	(AXB)	(AXB)
Without wrapping	5.36	5.88	5.62	7.00	8.00	7.50	6.56	6.18	6.94
Kraft	7.20	8.79	7.99	10.58	12.00	11.29	9.64	8.89	10.39
Butter paper	7.50	9.00	8.25	10.88	12.50	11.69	9.97	9.19	10.75
Cellophane	9.52	11.00	10.26	12.60	14.45	13.53	11.89	11.06	12.73
Polyethylene	9.87	11.65	10.76	13.35	15.18	14.27	12.51	11.61	13.42
Mean (BXC)	7.89	9.26	8.58	10.89	12.42	11.65	-----	9.39	10.85

L.S.D at 5 % level

Factor	Wrapping material (A)	Cut type (B)	Pulsing solution (C)	AXB	AXC	BXC	AXBXC
	1.783	1.128	1.128	2.522	2.522	1.595	3.567

Table (3): Effect of wrapping materials, type of cut, pulsing solutions and their interaction on flower vase life (day) of Chrysanthemum (*Dendranthema grandiflorum*, Ramat) cv. Discovery after dry cold storage for 4 days at 5°C during (2007).

Treatment	Pulsing solution						Mean		
	Distilled water			Preservative solution					
Wrapping material	Cut type								
	In air	Under water	Mean (AXC)	In air	Under water	Mean (AXC)	(A)	(AXB)	(AXB)
Without wrapping	5.10	5.56	5.33	6.50	7.61	7.06	6.19	5.80	6.59
Kraft	7.32	8.10	7.71	10.00	12.09	11.05	9.38	8.66	10.10
Butter paper	7.98	8.54	8.26	10.70	13.15	11.93	10.09	9.34	10.85
Cellophane	9.71	11.60	10.16	12.55	15.00	13.78	11.97	11.13	12.80
Polyethylene	10.00	11.00	10.50	13.70	15.50	14.60	12.55	11.85	13.25
Mean (BXC)	8.02	8.76	8.39	10.69	12.67	11.68	-----	9.36	10.72

L.S.D at 5 % level

Factor	Wrapping material (A)	Cut type (B)	Pulsing solution (C)	AXB	AXC	BXC	AXBXC
	1.813	1.147	1.147	2.564	2.564	1.622	3.626

3- Flower quality: Data in Table (4) illustrate that Chrysanthemum flowers packed in either polyethylene or cellophane and stored at 5 C for 4 days recorded the highest flower quality compared to the other treatments in both seasons. Flowers quality is largely visual and including an appearance of visual freshness, uniformite color and the lack of defect such as damage and wilting.

Results under discussion stated that storage period of Chrysanthemum cut flowers at 5°C for 4 days packed in wrapping materiais could be carried out without any negative effect on flowers quality compared to flowers without wrapping under the same condition. The flowers quality not packed stored at 5°C for 4 days was generally very poor quality. This is due to the water loss from flowers that contributed to reduce fresh flowers quality and marketable. These results coincided with those of El- Saka (1996,b) on *Narcissus Tazetta* cut flowers who mentioned that flowers packed in polyethylene bags then stored at 5°C for 5, 10, 15 and 20 days showed improved flowers quality. Regarding the type of recut data in Table (4) show that recutting the flowers under water was more effective treatment on flower quality than those recutting in air in both seasons. Pulsing the flowers of Chrysanthemum in a preservative solution improved the flower quality compared to distilled water pulsing in both seasons.

Regarding the effects of the interactions (wrapping materials x type of recut x pulsing solution), data in Table (4) indicate that the best flower quality was found with either polyethylene or cellophane bags recutting under water x pulsing in a preservative solution compared to the other treatments in both seasons. These results were in agreement with those of Florez et al., (1996) on spray Chrysanthemum who mentioned that pulsing treatment with distilled water + 0.52 mol/m^3 citric acid + 58.43 mol/m^3 sucrose + 0.69 mol/m^3 8- HQ + 2.9 improved the foliar quality. Jothi and Balakrishnamoorthy (2001) found that cut roses were treated with 8- Hydroxyquinoline sulfate (200 ppm) + citric acid (300 ppm) + aluminium sulfate (300 ppm) + sucrose (3%) and then packed in cellophane had the longest vase life.

Table (4): Effect of wrapping materials, type of cut, pulsing solutions and their interaction on flower quality of Chrysanthemum (*Dendranthema grandiflorum*, Ramat) cv. Discovery cut flowers after dry cold storage for 4 days at 5°C during 2006 and 2007.

Treatment	Pulsing solution									
	Distilled water		Preservative solution			Distilled water		Preservative solution		
	Cut type									
Wrapping material	2006					2007				
	In air	Under water	In air	Under water	Mean	In air	Under water	In air	Under water	Mean
Without wrapping	1.30	1.50	1.70	2.00	1.63	1.40	1.57	1.75	2.10	1.71
Kraft	2.55	3.00	3.50	4.00	3.26	2.50	3.10	3.45	4.00	3.26
Butter paper	2.59	3.00	3.72	4.00	3.33	2.65	3.20	3.79	4.10	3.44
Cellophane	3.50	4.25	4.52	5.00	4.32	3.60	4.50	4.70	5.00	4.45
Polyethylene	3.62	4.33	4.65	5.00	4.40	3.65	4.55	4.73	5.00	4.48
Mean of pulsing solution	2.96		3.13			3.07		3.86		
Mean of cut type	In air		Under water			In air		Under water		
	3.17		3.61			3.22		3.71		

Quality degree: 1= bad 2= moderate 3= good
4= very Good 5= excellent

4-The percentage of flower opening: Tables (5and 6) show that flowers packed in either polyethylene or cellophane bags represented highly significant increase in the percentage of flower opening (87.85 or 84.04 % and 86.85 or 84.23 % in the first and second seasons, respectively) compared to the other treatments.

Recutting the flowers under water significantly enhanced the percentage of flower opening over recutting in air in both seasons.

Regarding the effect of pulsing solution the data in Tables (5and 6) state that pulsing the flower in preservative solution significantly increased the percentage of flower opening over the treatment of pulsing in distilled water in the two seasons.

The effects of the interactions (wrapping materials x type of cut x pulsing solutions), shown in Tables (5, 6) indicate that the highest values of the percentage of flower opening was found with polyethylene or cellophane bags x recutting under water x pulsing in a preservative solution in both seasons. In this respect, El- Saka (1996,b) on *Narcissus tazetta* found that flowers packed in polyethylene bags then stored at 2 – 3 °C for 5, 10, 15 and 20 days enhanced buds opening. Also, El- Saka (2002) on cut flowers of *Antirrhinum majus* indicated that holding flowers continuously in silver nitrate (25 mg/l) + 8- Hydroxyquinoline sulfate (200 mg/l + sucrose (50 g/l) was the most effective in maximizing bud opening.

Table (5): Effect of wrapping materials, type of cut, pulsing solutions and their interaction on opening percentage of Chrysanthemum (*Dendranthema grandiflorum*, Ramat). cv. Discovery cut flowers after dry cold storage for 4 days at 5°C during (2006).

Treatment	Pulsing solution						Mean		
	Distilled water			Preservative solution					
Wrapping material	Cut type								
	In air	Under water	Mean (AXC)	In air	Under water	Mean (AXC)	(A)	(AXB)	(AXB)
Without wrapping	16.83	20.60	18.72	50.34	60.80	55.57	37.14	33.59	62.80
Kraft	50.41	70.45	60.43	75.18	80.60	77.89	69.16	63.05	78.63
Butter paper	50.60	70.98	60.79	75.50	80.91	78.21	69.50	83.10	40.70
Cellophane	70.82	80.60	75.71	86.44	98.30	92.37	84.04	75.53	75.95
Polyethylene	75.50	85.19	80.35	90.70	100.00	95.35	87.85	89.45	92.60
Mean (BXC)	52.83	65.56	59.20	75.63	84.12	79.88	------	64.23	74.84

L.S.D at 5 % level

Factor	Wrapping material (A)	Cut type (B)	Pulsing solution (C)	AXB	AXC	BXC	AXBXC
	2.479	1.568	1.568	3.506	2.218	3.506	4.959

Table (6): Effect of wrapping materials, type of cut, pulsing solutions and their interaction on opening percentage of Chrysanthemum (*Dendranthema grandiflorum*, Ramat) cv. Discovery cut flowers after dry cold storage for 4 days at 5 C during (2007).

Treatment	Pulsing solution						Mean		
	Distilled water			Preservative solution					
	Cut type								
Wrapping material	In air	Under water	Mean (AXC)	In air	Under water	Mean (AXC)	(A)	(AXB)	(AXB)
Without wrapping	20.20	25.55	22.88	50.82	62.00	56.41	39.64	35.51	64.10
Kraft	52.20	70.00	61.10	76.00	80.91	78.46	69.78	65.21	79.18
Butter paper	53.00	70.85	61.93	77.42	81.00	79.21	70.57	81.93	43.78
Cellophane	71.35	80.55	75.95	87.00	98.00	92.50	84.23	75.46	75.93
Polyethylene	73.35	85.00	79.18	90.50	98.54	94.52	86.85	89.28	91.77
Mean (BXC)	54.02	66.39	60.21	76.35	84.09	80.22	-------	65.18	75.24

L.S.D at 5 % level

Factor	Wrapping material (A)	Cut type (B)	Pulsing solution (C)	AXB	AXC	BXC	AXBXC
	2.137	1.352	1.352	3.02	1.911	3.022	4.274

5- **Water uptake:** Data in Tables (7and 8) show that all the wrapping materials significantly increased the water uptake over the treatment without wrapping in both seasons.

Flowers wrapped in polyethylene followed by those in cellophane produced the highest water uptake and the differences were significant compared to the other treatments in both seasons.

Concerning the effect of type of cut data in Tables (7and 8) reveal that recutting the flowers under water was significantly more effective (34.75 and 34.57 cm^3 in the first and second seasons, respectively) than those of recutting in air with significant differences. Also, using a preservative solution significantly enhanced the water uptake compared to the pulsing in distilled water in both seasons.

The data of interactions (wrapping materials x type of cut x pulsing solutions), indicate that the most effective treatment for enhancing water uptake was polyethylene followed by cellophane bags x recutting under water x pulsing in preservative solution compared to the other treatments in both seasons.

In this concern Meeteren *et al.*, (1999) on cut Chrysanthemum flowers found that the rehydration ability of these flowers was restored when the stem ends were trimmed under water. Recutting in air did not restore rehydration ability. Bleeksma *et al.*, (2003) on *Rosa hybrid* (Madelon roses) found that with recutting the stem ends under water, no cavitations were observed in stems which started with the air in xylem by cutting. This air, bubbles may impede water uptake.

6- The percentage of flower fresh weight increase: Data in Tables (9and 10) show that using different kinds of wrapping materials to wrap flowers before dry cold storage increased the percentage of flower fresh weight increase over control and the differences were significant in both seasons (except the treatment of kraft in the first season). However, the flowers wrapped in polyethylene followed by those wrapped in cellophane were the most effective treatments when compared to the other treatments in both seasons.

Table (7): Effect of wrapping materials, type of cut, pulsing solutions and their interaction on water uptake (cm) of Chrysanthemum (*Dendranthema grandiflorum*, Ramat) cv. Discovery cut flowers after dry cold storage for 4 days at 5°C during (2006).

Treatment	Pulsing solution						Mean		
	Distilled water			Preservative solution					
Wrapping material	Cut type								
	In air	Under water	Mean (AXC)	In air	Under water	Mean (AXC)	(A)	(AXB)	(AXB)
Without wrapping	20.33	22.00	21.17	26.83	30.17	28.50	24.83	23.58	26.09
Kraft	25.00	26.17	25.59	32.83	38.67	35.75	30.67	28.92	32.42
Butter paper	26.17	27.80	26.99	33.83	39.60	36.72	31.85	30.00	33.70
Cellophane	30.80	34.60	32.70	40.17	45.33	42.75	37.73	35.49	39.97
Polyethylene	32.90	35.50	34.20	43.83	47.70	45.77	39.98	38.37	41.60
Mean (BXC)	27.04	29.21	28.13	35.50	40.29	37.90	-----	31.27	34.75

L.S.D at 5 % level

Factor	Wrapping material (A)	Cut type (B)	Pulsing solution (C)	AXB	AXC	BXC	AXBXC
	2.595	1.641	1.641	3.67	2.321	3.67	5.189

Table (8): Effect of wrapping materials, type of cut, pulsing solutions and their interaction on water uptake (cm) of Chrysanthemum (*Dendranthema grandiflorum*, Ramat) cv. Discovery cut flowers after dry cold storage for 4 days at 5 C during (2007).

Treatment	Pulsing solution						Mean		
	Distilled water			Preservative solution					
Wrapping material	Cut type								
	In air	Under water	Mean (AXC)	In air	Under water	Mean (AXC)	(A)	(AXB)	(AXB)
Without wrapping	21.00	23.00	22.00	27.00	30.50	28.75	25.38	24.00	29.50
Kraft	25.60	26.60	26.10	33.40	38.13	35.77	30.93	30.60	35.04
Butter paper	27.20	28.00	27.60	34.00	38.80	36.40	32.00	37.50	26.75
Cellophane	31.08	34.18	32.63	39.00	43.00	41.00	36.82	32.37	33.40
Polyethylene	33.00	36.70	34.85	42.00	46.80	44.40	39.63	38.59	41.75
Mean (BXC)	27.58	29.70	28.64	35.08	39.45	37.26	-----	31.33	34.57

L.S.D at 5 % level

Factor	Wrapping material (A)	Cut type (B)	Pulsing solution (C)	AXB	AXC	BXC	AXBXC
	1.90	1.20	1.20	2.687	1.699	2.687	3.799

Table (9): Effect of wrapping materials, type of cut, pulsing solutions and their interaction on fresh weight of Chrysanthemum (*Dendranthema grandiflorum*, Ramat) cv. Discovery cut flowers after dry cold storage for 4 days at 5°C during (2006).

Treatment	Pulsing solution						Mean		
	Distilled water			Preservative solution					
Wrapping material	Cut type								
	In air	Under water	Mean (AXC)	In air	Under water	Mean (AXC)	(A)	(AXB)	(AXB)
Without wrapping	1.17	1.79	1.48	3.04	3.81	3.43	2.45	2.11	2.80
Kraft	2.45	2.75	2.60	3.50	5.21	4.36	3.48	2.80	3.98
Butter paper	2.59	2.82	2.71	3.74	6.16	4.95	3.83	3.17	4.49
Cellophane	3.56	3.90	3.73	4.80	7.55	6.18	4.95	4.18	5.73
Polyethylene	3.91	4.20	4.06	5.04	8.00	6.52	5.29	4.48	6.10
Mean (BXC)	2.74	3.09	2.91	4.02	6.15	5.09	-----	3.38	4.62

L.S.D at 5 % level

Factor	Wrapping material (A)	Cut type (B)	Pulsing solution (C)	AXB	AXC	BXC	AXBXC
	1.290	0.816	0.816	1.825	1.154	1.825	2.580

Table (10): Effect of wrapping materials, type of cut, pulsing solutions and their interaction on fresh weight of Chrysanthemum (*Dendranthema grandiflorum*, Ramat) cv. Discovery cut flowers after dry cold storage for 4 days at 5°C during (2007).

Treatment	Pulsing solution						Mean		
	Distilled water			Preservative solution					
Wrapping material	Cut type								
	In air	Under water	Mean (AXC)	In air	Under water	Mean (AXC)	(A)	(AXB)	(AXB)
Without wrapping	1.50	1.90	1.70	2.85	3.90	3.38	2.54	2.18	3.50
Kraft	3.00	3.50	3.25	4.00	5.55	4.78	4.01	3.68	5.15
Butter paper	3.20	3.75	3.48	4.15	6.00	5.08	4.28	5.60	2.90
Cellophane	4.30	4.95	4.63	6.00	7.67	6.84	5.73	4.53	4.88
Polyethylene	4.70	5.30	5.00	6.50	8.30	7.40	6.20	6.31	6.80
Mean (BXC)	3.34	3.88	3.61	4.70	6.28	5.49	------	4.02	5.08

L.S.D at 5 % level

Factor	Wrapping material (A)	Cut type (B)	Pulsing solution (C)	AXB	AXC	BXC	AXBXC
	1.293	0.818	0.818	1.829	1.157	1.829	2.586

Regarding the effect of type of recutting, it can be concluded from Tables (9and 10) that recutting the flowers under water significantly enhanced the fresh weight increase of flowers after cold storage in both seasons.

Also, flowers pulsed in a preservative solution produced significantly higher value (5.09 and 5.49 % in the first and second seasons, respectively) than those pulsed in distilled water (2.91 and 3.61 %) in the first and second seasons, respectively).

The results of interaction (wrapping materials x type of cut x pulsing solutions), show that the most effective treatment in this regard was the treatment of wrapping with polyethylene followed by cellophane x recutting under water x pulsing in preservative solution in both seasons. This agreed with the results found by Meeteren *et al.*, (2006) on *Chrysanthemum morifolium* who pointed out that the air is aspired directly after cutting (into the opened xylem conduits) was solely responsible for the blockage that developed during the first 1-2 after cutting. Amin (2006) on some cut foliage stated that holding solution of 8- HQS + sucrose enhanced the fresh weight percentage.

7- The percentage of Carbon dioxide (CO_2): Results in Table (11) indicate that CO_2 increased according to the flowers respiration in tight bags. In this respect flowers wrapped in either polyethylene or cellophane gave the highest value (0.89 or 0.87 and 0.90 or 0.87 in the first and second seasons, respectively) compared to the other treatments. The main effect of using polyethylene bags is to raise CO_2 concentration around flowers, in order to reduce respiration rate, carbohydrates metabolism in flowers tissues, prevent ethylene action and maintain flowers quality.

Table (11): Effect of wrapping materials, type of cut, pulsing solutions and their interaction on Carbon dioxide percentage of Chrysanthemum (*Dendranthema grandiflorum*, Ramat) cv. Discovery cut flowers after dry cold storage for 4 days at 5 C during 2006 and 2007.

Treatment	Pulsing solution									
	Distilled water		Preservative solution			Distilled water		Preservative solution		
	Cut type									
Wrapping material	2006					2007				
	In air	Under water	In air	Under water	Mean	In air	Under water	In air	Under water	Mean
Without wrapping	0.03	0.05	0.06	0.07	0.05	0.03	0.06	0.06	0.08	0.06
Kraft	0.21	0.24	0.32	0.39	0.29	0.25	0.29	0.34	0.41	0.32
Butter paper	0.30	0.33	0.42	0.46	0.38	0.31	0.35	0.42	0.49	0.39
Cellophane	0.76	0.82	0.93	0.96	0.87	0.80	0.85	0.89	0.95	0.87
Polyethylene	0.81	0.84	0.93	0.98	0.89	0.83	0.87	0.91	0.97	0.90
Mean of pulsing solution	0.44		0.55			0.46		0.55		
Mean of type of cut	In air		Under water			In air		Under water		
	0.48		0.51			0.48		0.53		

Ethylene binding is depended on oxygen and competitively inhibited by CO2 and STS. CO_2 certainly inhibited the ethylene- promoter development forming- enzyme (Bufler, 1986). Also, recutting the flowers under water was more effective treatment in enhancing the percentage of CO2 than those recut in air in both seasons.

Pulsing the flowers in preservative solution improved the percentage of CO_2 compared to distilled water in both seasons.

Concerning the effects of the interactions (wrapping materials x type of cut x pulsing solutions), data in Table (11) record that recutting the flowers under water before pulsing in a preservative solution and wrapping the flowers in either polyethylene or cellophane increased CO_2 % compared to the other treatments in both seasons.

8- **The percentage of total soluble sugars in petals:** the data in Table (12) demonstrate that the percentage of total soluble sugars was decreased in flowers without wrapping compared to the other treatments in both seasons.

However, wrapping the flowers with either polyethylene or cellophane recorded the highest increase in the percentage of total soluble sugars in petals compared to the other treatments in both seasons. This is due to the reduction in respiration and metabolic rate of the flowers. Also, data in Table (12) point out that recutting under water recorded higher content of total soluble sugars in petals than recutting in air in both seasons.

Results in Table (12) indicate that pulsing the flowers in a preservative solution increased the percentage of total soluble sugars compared to pulsing in distilled water in both seasons.

Meantime, flowers recut under water then pulsed in a preservative solution and wrapped in either polyethylene or cellophane before storage at 5° C for 4 days recorded the highest content of total soluble sugars in petals than the other treatments in both seasons.

Table (12): Effect of wrapping materials, type of cut, pulsing solutions and their interaction on total soluble sugars percentage of Chrysanthemum (*Dendranthema grandiflorum*, Ramat) cv. Discovery cut flowers after dry cold storage for 4 days at 5°C during 2006 and 2007.

Treatment	Pulsing solution									
	Distilled water		Preservative solution			Distilled water		Preservative solution		
	Cut type									
	2006					2007				
Wrapping material	In air	Under water	In air	Under water	Mean	In air	Under water	In air	Under water	Mean
Without wrapping	1.42	1.50	2.04	2.20	1.79	1.51	1.57	2.00	2.12	1.8
Kraft	2.11	2.30	2.69	2.80	2.48	2.08	2.24	2.55	2.75	2.41
Butter paper	2.22	2.45	2.83	3.00	2.63	2.12	2.40	2.74	2.96	2.56
Cellophane	2.74	2.96	3.40	4.30	3.35	2.80	3.20	3.82	4.20	3.51
Polyethylene	2.80	3.05	3.60	4.43	3.47	2.93	3.31	3.90	4.54	3.67
Mean of pulsing solution	2.36		3.13			2.42		3.16		
Mean of type of cut	In air		Under water			In air		Under water		
	2.59		2.90			2.65		2.93		

These results are in line with those Sindhu and Pathania (2004) on lily who showed that packing flowers in polyethylene sleeves and storing at 1° C was more effective than those stored them in kraft paper. Amin (2006) on some cut foliage showed that the treatment of pulsing the cut foliage in 8-Hydroxyquinoline sulfate (200 mg/l) + sucrose (2%) and packaging gave the maximum value of total sugars content.

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تقييم بعض المغلفات المختلفة و معاملات ما بعد الحصاد على أزهار الأراولا المقطوفة

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الملخص العربي

أجريت هذه الدراسة فى قسم بحوث نباتات الزينة و تنسيق الحدائق – معهد بحوث البساتين بالجيزة خلال موسمى ٢٠٠٦ و ٢٠٠٧ على أزهار الأراولا صنف ديسكفرى (زهرة متعددة الزهيرات) و التى تم قطفها عند تفتح الزهيرة الرئيسية بها.

و تم إختبار ٣ عوامل وهى :

١ – أنواع مختلفة من المغلفات و هى البولى إثيلين، السوليفان، ورق الزبدة، و الكرافت (الورق البنى) من ناحية الحفاظ على جودة الأزهار و رطوبتها.

٢ – نوعين من طرق إعادة قطع نهايات سيقان الأزهار و هما (قطع تحت الماء و قطع فى الهواء).

٣ – نوعين من محاليل الغمس و هما الماء المقطر ، محلول مكون من سكروز (٣%) + ٨- هيدروكسى كينولين سترات (٢٥٠مجم/اللتر) + نترات الفضة (٢٥ مجم/اللتر) + حمض الستريك (١٥٠ مجم/اللتر).

و كانت التجربة كالآتى: تم تقسيم الأزهار إلى مجموعتين الأول تم فيها قطع نهايات سيقان الأزهار تحت الماء و الثانى تم فيها القطع فى الهواء خارج الفازة تم غمس الأزهار مباشرة فى محاليل الغمس السابق ذكرها و ذلك لمدة ١٨ ساعة. ثم بعد ذلك تم تخزين الأزهار تخزين جاف على درجة حرارة ٥°م لمدة ٤ أيام.

و الهدف من إجراء هذا البحث الحفاظ على جودة الأزهار لأطول فترة ممكنة حتى تصل بعد شحنها و تصديرها إلى المزادات التى تقام فى بعض الدول الأوروبية أو تصديرها أى دول اخرى أو إلى الإستهلاك المحلى بحالة عالية الجودة.

بعد إنتهاء فترة التخزين تم وضع الأزهار فى فازات تحتوى على ماء مقطر فقط وتم متابعتها و تسجيل البيانات.

و من أهم النتائج التى تم الحصول عليها:

- إعادة قطع نهايات سيقان الأزهار تحت الماء كان الأكثر تأثيرا فى زيادة كل من إمتصاص الماء و الوزن الطازج للأزهار حيث أن هذه الطريقة تؤدى إلى إزالة الجزء الذى تم إنسداده بالهواء أثناء القطع فى المزرعة و يكون غشاء رقيق من الماء على مكان القطع و بالتالى يؤدى إلى تحسين قدرة الأزهار على إمتصاص الماء. بينما طريقة إعادة قطع نهايات سيقان الأزهار فى الهواء تؤدى إلى إنسداد أوعية الإمتصاص فى الزهرة بفقاقيع الهواء التى يعوق إمتصاص الأزهار للماء و من ثم تفقد مائها و تذبل و تنتهى فترة حياتها سريعا.
- أدى غمس نهايات سيقان أزهار الأراولا فى المحلول المغذى المكون من سكروز (٣%) + ٨- هيدروكسى كينولين سترات (٢٥٠مجم/اللتر) + نترات الفضة (٢٥ مجم/اللتر) + حمض الستريك (١٥٠ مجم/اللتر) لمدة ١٨ ساعة إلى زيادة عمر الأزهار فى الفازات و إلى نقص معدل الفقد فى وزن الأزهار نتيجة التخزين البارد و إلى زيادة نسبة تفتح الزهيرات.
- تغليف الأزهار فى أكياس من البولى إثيلين أو السوليفان أعطت أحسن النتائج و التى أدت إلى زيادة نسبة ثانى أكسيد الكربون (ك أ٢) حول الأزهار و بالتالى إنخفاض معدل التنفس مما يترتب على ذلك الإحتفاظ بالكربوهيدرات داخل الأزهار مما يؤدى إلى الحفاظ على جودة الأزهار.
- إعادة قطع نهايات سيقان الأزهار تحت الماء ثم غمسها فى المحلول المغذى المكون من سكروز (٣%) + ٨- هيدروكسى كينولين سترات (٢٥٠مجم/اللتر) + نترات الفضة (٢٥ مجم/اللتر) + حمض الستريك (١٥٠ مجم/اللتر) لمدة ١٨ ساعة ثم التعبئة فى أكياس من البولى إثيلين أو السولبفان كانت من أحسن المعاملات التى أدت إلى زيادة عمر الأزهار فى الفازات و خفضت من إستنزاف محتوى بتلات الأزهار من السكريات نتيجة إنخفاض معدل التنفس و العمليات الحيوية داخل الأزهار.