

## EFFECT OF SOME ETHYLENE INHIBITORS ON THE KEEPING QUALITY AND EXTENDING THE VASE LIFE OF CARNATION (*DIANTHUS CARYOPHYLLUS*, L.) CUT FLOWERS

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(Manuscript received 6 August 2007)

### Abstract

The aim of this research was to use the environmental safe materials compared these ones with the effect of silver thiosulfate (STS) on the keeping quality of carnation flowers. Flowers of carnation *Dianthus caryophyllus* cv. "Banyas" (white flowers) were harvested at the immature stage (star stage) and were dipped in a distilled water, STS (1:4 mμ) and jasmine oil at 0.015 and 0.030% for one hour. The flowers were divided in two groups. One group (0.0 time) was placed in vases with a distilled water and the second was dry stored at 0°C for 4 and 6 weeks. The obtained data indicated that the weight loss percentage increased with extending storage period. Dry storage of carnation flowers for 0.0 time and 4 weeks at 0°C showed the best results compared to 6 weeks storage. Results concerning vase life period and flower opening revealed that dipping of cut flowers in jasmine oil was the most effective treatment for enhancing flowers quality and prolonging vase life by improving water uptake, reducing depletion of sugars content and pigments in the leaves compared to the other treatments.

### INTRODUCTION

Carnation *Dianthus caryophyllus*, Herb., cv. "Banyas" (white flowers), belongs to family Caryophyllaceae. It is native to Mediterranean region. Flowers are very attractive and have many ornamental utilization. These flowers are cut off with a long stalk and picking may be done in mature bud stage for facilitating handling, transportation and lowering damage possibilities and also in the earlier stage (star). The sensitivity of these flowers to ethylene shortens vase life as it stimulates a quick opening of flowers and causes sleepiness which may constitute a big loss to producers and traders. One material was proven its effectiveness to delay the onset of flower senescence, named silver thio sulfate (STS). It is known to oppose ethylene effects and keep the longevity of flowers for a certain period. This material has some environmental hazards because of its polluting impact.

Since jasmonates were discovered in jasmines (*Jasminum grandiflour* L.) (Ueda, 1991) much useful researches have followed. Jasmonates (jasmine oil) have two effective components: methyl jasmonate (MJ) and jasmonic acid (JA). methyl

jasmonate (MJ) is a natural growth regulator used to induce plant defense responses. It was tested for postharvest to control of the grey mould disease in various cut rose cultivars (Meir *et al.*, 1998).

The aim of this research was to use the environmental safe materials compared these ones with the effect of silver thiosulfate (STS) on the keeping quality of carnations flowers harvested at the immature stage (star stage).

### MATERIALS AND METHODS

This research was carried out at Horticultural Research Institute, Giza for two successive seasons (2004 and 2005), Carnation flowers (*Dianthus caryophyllus*) cv. Banyas (white flowers), were obtained from a commercial farm. The uniform flowers were harvested at star stage (when petals emerge about 5cm above the calyx) in the early morning. Precooling of flowers was performed by placing them in ice cold water for three hours. Flower stems were adjusted to 50 cm long with the same number of leaves. The experiment was conducted on the first of January during the seasons of 2004 and 2005. After eliminating about 3 cm from the stalk base flowers were divided into four groups and were placed for one hour in the following pulsing solutions: distilled water (control), STS (silver thiosulfate) which was prepared at the ratio of 1AgNO<sub>3</sub> to 4 millimolar sodium thiosulfate and jasmine oil dissolved in ethanol of two concentrations (0.015and 0.030%). The flowers were divided into three groups: flowers were dipped in the bud opening solution [(30 gm/l sucrose +200 mg/L 8-HQC (pH=4.6))] for 48 hours, then transferred to vases containing distilled water under lab conditions (0.0 time). The other two groups were wrapped in tightly sealed polyethylene film (30 micron thickness) then packed in carton boxes to be stored at 0.0°C for 4 and 6 weeks. At the end of the storage period, all groups were dipped in the bud opening solution as mentioned above then held in distilled water to complete its shelf life.

The experiments were conducted under lab conditions (24 hr fluorescent light at 1000 lux, 18±2°C and 40-50% RH).

Layout of the experiment was completely randomized in a factorial design with three replicates per treatment, each replicate consisted of 4 flowers. i.e. 12 flowers in each treatment.

#### 1-Measurements

- 1- Flower weight loss percentage during storage period.
- 2- Flower longevity: the vase life period was defined as the number of days between full opening of flowers to clear enrolling and wilting of the petals (days).

- 3- Flower diameter (cm) was measured by vernier caliper.
- 4- Flower weight increase percentage
- 5- Flower opening percentage
- 6- Water uptake (cm<sup>3</sup>/flower)
- 7- Chlorophyll and carotenoids (mg/100g) were determined in leaves colorimetrically according to Saric *et al.*, (1967).
- 8- Reducing and total sugars in petals (percentage) were determined colorimetrically according to the method described by Dubois *et al.*, (1956).

## 2-Statistical analysis

All data were subjected to statistical analysis according to the procedure reported by Snedecor and Cochran (1982) and means were compared by Duncan's (1955) multiple range test at the 5% level of probability in the two seasons.

## RESULTS AND DISCUSSION

1- Flowers weight loss percentage during dry storage at 0°C: The data in Table (1) clearly indicate that flower weight loss percentage of carnation flowers was increased gradually when dry storage periods exceeded four weeks to reach six weeks at 0°C in the two seasons. This loss was originally attributed to flowers respiration and transpiration. The highest weight loss in both seasons was achieved with distilled water for all storage periods with its maximum at six weeks, followed by STS then jasmine oil at 0.015 and 0.030% concentrations. These results are in agreement with El-Saka (1996) on Iris flowers who found that weight loss of flowers increased with extending storage period up to 21 days. Meir *et al.*, (1996) found that using methyl jasmonate increased storability of avocado by reducing chilling injury.

Data presented in Tables (2&3) show flower longevity (days), flower diameter (cm) and opening percentage of *Dianthus caryophyllus* cv Banyas flowers as affected by pulsing solution, storage period and their interactions

2- Flowers longevity (days) and diameter (cm): the main effect of pulsing solutions showed that all pulsing solutions significantly enhanced flower longevity compared with pulsing in distilled water. The flowers pulsed in jasmine oil at 0.03% followed by 0.015% had the best effectiveness in increasing flower longevity and diameter followed by STS while holding in the distilled water had the least effect. The flowers longevity after the end of storage period was less than unstored flowers (0 time). This is in agreement with El-Saka and Auda (1997) on amaryllis who pointed out that flowers harvest stage at 1 or II without storage can last even 10.0: 11.16 days. Also, data concerning flower diameter show in clear way a similar trend to that

of flower longevity. The results of interaction proved that dipping flower bases in jasmine oil and STS before storage for 0 time and then holding in vase solution significantly increased longevity and flower diameter in both seasons as compared to other treatments. Storing flowers for six weeks was critical when using all pulsing solutions for both flower longevity and diameter comparing to four weeks storage.

This is in agreement with Gast (2001) on *Paeonia lactifolia* who stated that methyl Jasmonate improved the vase life of the flowers at 8 weeks of cold storage at 0°C and at 10 weeks were larger. Menguc *et al.* (1994) mentioned that STS treatment increased vase life and flower diameter but cold storage decreased it.

3. Flower opening (Table, 4): the data indicate that six weeks storage significantly decreased opening percentage 58.33 and 56.25% compared with other treatments in the first and second seasons, respectively. Generally with extending storage periods there was a noticeable reduction in the opening percentage as compared with unstored flowers (0.0 time). Similar results were reported by Bang *et al.*, (1996) on *Dianthus barbatus* who found that when flowers were stored at 2°C for 1-2 weeks the increase in storage duration was accompanied by decreasing of flowering opening. The pulsing solution treatments indicated their superiority over distilled water which had the least value of opening percentage 36.10 and 47.22% followed in an ascending order by STS 72.1 and 75.0%, jasmine oil at 0.015% (83.33 and 83.33%) and jasmine oil at 0.030% (83.33 and 86.11%) in both seasons, respectively. These results are in agreement with Gast (2001) on *Paeonia lactifolia* who found that methyl jasmonate yielded best results for the opening of the flowers at 8 weeks and at 10 weeks treatment by methyl jasmonate.

Table 1. Effect of pulsing solutions and storage period at 0°C on flower weight Loss percentage of *Dianthus caryophyllus*, Linn. cv. Banyas during the two seasons of 2004 and 2005.

Treatments	Cont.	STS	Jas1	Jas2	Mean
St. Periods	2004				
4weeks	0.76	0.48	0.19	0.18	0.40
6weeks	2.45	0.80	0.49	0.42	1.04
Mean	1.61	0.64	0.34	0.30	0.72
St. Periods	2005				
4weeks	0.81	0.31	0.10	0.06	0.32
6weeks	2.83	0.45	0.28	0.25	0.95
Mean	1.82	0.38	0.19	0.16	0.64

Table 2. Effect of pulsing solutions and storage period at 0°C on flower longevity percentage of *Dianthus caryophyllus*, Linn. cv. Banyas during the two seasons of 2004 and 2005.

Treatments	Cont.	STS	Jas1	Jas2	Mean					
St. period	2004									
0 week	17.58	d	25.17	b	27.08	a	27.87	a	24.425	A
4weeks	14.50	f	16.17	e	18.08	d	19.75	c	17.125	B
6weeks	13.00	g	14.50	f	15.00	ef	15.58	ef	14.52	C
Mean	15.03	D	18.61	C	20.05	B	21.07	A		
St. period	2005									
0 week	14.67	d	22.08	b	24.58	a	25.00	a	21.583	A
4weeks	11.45	f	14.30	de	16.55	c	17.22	c	14.88	B
6weeks	9.67	g	12.20	f	13.37	e	14.00	de	12.31	C
Mean	11.93	C	16.19	B	18.17	A	18.74	A		

Means within each column followed by different letters are significantly different according to Duncan's multiple range at 5 %.

St. Periods : Storage Periods.

Control : distilled water.

Jas1 : jasmine oil at 0.015 %.

STS: silver thiosulfate 1:4mM.

Jas2: jasmine oil at 0.030 %.

EFFECT OF SOME ETHYLENE INHIBITORS ON THE KEEPING  
QUALITY AND EXTENDING THE VASE LIFE OF CARNATION  
(*DIANTHUS 'CARYOPHYLLUS, L.*) CUT FLOWERS

Table 3. Effect of pulsing solutions and storage period at 0°C on flower diameter (cm.) of *Dianthus caryophyllus*, Linn. cv. Banyas during the two seasons of 2004 and 2005.

Treatments	Cont.		STS		Jas1		Jas2		Mean	
St. period	2004									
0 week	3.19	f	6.98	b	7.00	b	7.69	a	6.22	A
4weeks	3.14	f	4.11	e	5.26	c	5.47	c	4.50	B
6weeks	2.29	g	3.33	f	4.47	de	4.75	d	3.71	C
Mean	2.87	D	4.81	C	5.58	B	5.97	A		
St. period	2005									
0 week	5.88	cde	7.49	ab	7.94	a	8.03	a	7.34	A
4weeks	3.37	f	6.00	cde	6.41	cd	6.83	bc	5.65	B
6weeks	2.40	g	5.01	e	5.50	de	5.84	cde	4.69	C
Mean	3.88	C	6.17	B	6.62	AB	6.90	A		

Table 4. Effect of pulsing solutions and storage period at 0°C on flower opening percentage of *Dianthus caryophyllus*, Linn. cv. Banyas during the two seasons of 2004 and 2005.

Treatments	Cont.		STS		Jas1		Jas2		Mean	
St. period	2004									
0 week	66.67	c	83.00	a	83.33	a	83.33	a	79.083	A
4weeks	33.33	e	75.00	b	83.33	a	83.33	a	68.748	B
6weeks	8.31	f	58.33	d	83.33	a	83.33	a	58.325	C
Mean	36.10	C	72.11	B	83.33	A	83.33	A		
St. period	2005									
0 week	75.00	c	100.00	a	100.00	a	100.00	a	93.75	A
4weeks	41.67	e	75.00	c	75.00	c	83.33	b	68.75	B
6weeks	25.00	f	50.00	d	75.00	c	75.00	c	56.25	C
Mean	47.22	D	75.00	C	83.33	B	86.11	A		

Means within each column followed by different letters are significantly different according to Duncan's multiple range at 5 %.

St. Periods :Storage Periods

Control : distilled water.

Jas1 : jasmine oil at 0.015 %

STS : silver thiosulfate 1:4mM

Jas2 : jasmine oil at 0.030 %

The interaction between (pulsing solutions x storage period) indicated that the highest opening percentage was obtained with flowers pulsed with either jasmine oil (0.030 and 0.015%) or STS at 0-time (unstored flowers) in the two seasons.

4. Water uptake: data in Table (5) show differences in water uptake ( $\text{cm}^3$ ) and flower fresh weight percentage of *Dianthus caryophyllus* (cv Banyas) when subjected to different pulsing solutions, storage periods. At 0-time (unstored flowers) the rate of water uptake was significantly higher than for flowers stored for four and six weeks in both seasons. The flowers stored in cold temperature for four weeks had a significantly higher magnitude in absorbing water than those stored for six weeks in both seasons. In this concern Song *et al.*, (1995) found that by extending storage period solution uptake decreased in flowers of *Dianthus* hybrid. Also, using pulsing solutions significantly enhance the water uptake and the highest effective pulsing solution in this regard was jasmine oil at 0.015% followed by jasmine oil at 0.030% and STS at the last position.

The data of interaction (pulsing solutions X storage periods) indicate that the most effective treatment for enhancing water uptake was jasmine oil pulsing at 0.015% followed by storage at 0°C for 0-time (unstored flowers) and 4 weeks compared to the other treatments in a significant way in both seasons. The efficiency of flowers for water uptake in vase decreased greatly by long storage period (six weeks) more than with four weeks. This was obvious clearly for all pulsing solutions and jasmine oil (0.015 and 0.030%) and STS pulsing which enhanced water uptake more than those of distilled water in both seasons and the differences were significant.

5-The percentage of flower fresh weight increase in vases: (Table, 6) the effect of storage period indicated that 0-time (unstored flowers) treatment recorded an increase in the flower fresh weight when compared to cold storage periods of 4 and 6 weeks in both seasons. Storage for four weeks enhanced significantly the fresh weight of flowers placed in vases after storage more than six weeks in both seasons. This work on carnation indicated the presence of a higher reduction in the fresh weight of flowers during storage which might be due to water loss as storage period increases so, four weeks storage was preferred to six weeks in this respect. Pulsing solution i.e. jasmine oil and STS significantly enhanced the fresh weight of flowers placed in vases after storage periods more than those pulsed in distilled water only. However, jasmine oil pulsing gained more weight than those of STS in both seasons. The results of interaction (pulsing solutions X storage period) show that the most effective treatment in this regard was the treatment of dipping jasmine oil x stored at 0-time (unstored flowers) and four weeks cold stored flowers which gained more fresh weight during

EFFECT OF SOME ETHYLENE INHIBITORS ON THE KEEPING  
QUALITY AND EXTENDING THE VASE LIFE OF CARNATION  
(*DIANTHUS 'CARYOPHYLLUS, L.*) CUT FLOWERS

both seasons. Secondly the treatment of STS pulsing x at 0-time (unstored flowers) and four weeks storage flowers in a significant way. This agreed with the results found by Merodio and Plaza (1989) on *Gladiolus*.

6-Chlorophyll content in vases: data presented in Table, (7 & 8 & 9) record a continuous decrease in chlorophyll a and b and increase in carotenoids content with the extension of storage period. Jasmine oil at 0.030% increased the level of chlorophyll a and b as compared to the other pulsing solutions in both seasons. On other hand, control treatment and STS treatment increased only the level of carotenoids as compared to other treatments in both seasons.

Table 5. Effect of pulsing solution and storage period at 0°C on water uptake (cm<sup>3</sup>) of *Dianthus caryophyllus*, Linn. cv. Banyas during the two seasons of 2004 and 2005.

Treatments	Cont.		STS		Jas1		Jas2		Mean	
St. period	2004									
0 week	20.00	d	25.25	c	29.00	a	26.83	b	25.27	A
4weeks	13.83	g	16.33	f	18.50	e	18.75	e	16.853	B
6weeks	10.00	i	11.33	h	12.25	h	12.33	h	11.478	C
Mean	14.61	D	17.64	C	19.92	A	19.30	B		
St. period	2005									
0 week	32.08	c	32.17	c	38.67	a	36.08	b	34.75	A
4weeks	22.25	fg	27.08	e	28.42	d	27.33	e	26.27	B
6weeks	18.75	h	21.75	g	22.67	f	22.92	f	21.523	C
Mean	24.36	D	27.00	C	29.92	A	28.78	B		



Table 6. Effect of pulsing solution and storage period at 0°C on flower fresh weight increase (%) of *Dianthus caryophyllus*, Linn. cv. Banyas during the two seasons of 2004 and 2005).

Treatments	Cont.		STS		Jas1		Jas2		Mean	
St. period	2004									
0 week	4.18	e	6.00	bc	6.20	b	6.90	a	5.82	A
4weeks	3.37	g	4.98	d	5.80	c	5.93	c	5.02	B
6weeks	2.00	h	3.66	f	4.20	e	4.80	d	3.67	C
Mean	3.18	D	4.88	C	5.40	B	5.88	A		
St. period	2005									
0 week	4.65	g	5.65	d	7.19	a	7.17	a	6.17	A
4weeks	3.40	j	4.50	h	6.00	c	6.20	b	5.03	B
6weeks	2.20	k	3.80	i	5.02	e	4.95	f	3.99	C
Mean	3.42	D	4.65	C	6.07	B	6.11	A		

Means within each column followed by different letters are significantly different according to Duncan's multiple range at 5 %.

St. Periods :Storage Periods

Control : distilled water.

STS: silver thiosulfate 1:4mM

Jas1 : jasmine oil at 0.015 %

Jas2: jasmine oil at 0.030 %

It can be concluded from the interaction between storage period and pulsing solutions, that the treatments of jasmine oil at 0.030% and storage for 0-time (unstored flowers) followed by 4 weeks storage improved chlorophyll contents when compared to other treatments in both seasons.

7-Total and reducing sugars percentage in petals: data in Tables (10 & 11) indicate that both total and reducing sugars percentage have similar response to pulsing solution, storage period and their interaction. Thus, the storage period for 0-time (unstored flowers), 4 weeks and 6 weeks treatments decreased total and reducing sugars especially with prolonging storage periods. As for the pulsing solutions, it is clear that all pulsing solutions increased both sugar types in petals comparing to distilled water in both seasons. Jasmine oil at 0.030% gave the highest value compared to the other treatments. This may be attributed to jasmine oil effect to slow some metabolic processes such as respiration and enhance juvenility leading to consumption of sugars by hindering ethylene action and retarding senescence of the flowers quickly and in turn utilization of sugars, since senescence of cut flowers is closely related to depletion of energy required for reactions of anabolism (Paulin,

1986). Similarly, Sacoils and Chin (1976) pointed out that depletion of available carbohydrates was an important factor influencing the vase-life of cut flowers.

Table 7. Effect of pulsing solutions and storage period at 0°C on chlorophyll a percentage of *Dianthus caryophyllus*, Linn. cv. Banyas during the two seasons of 2004 and 2005.

Treatments	Cont.	STS	Jas1	Jas2	Mean
St. period	2004				
O-Time	3.06	3.90	5.22	5.80	4.50
4weeks	2.73	2.96	5.08	5.50	4.07
6weeks	2.32	2.40	4.75	5.08	3.64
Mean	2.70	3.09	5.02	5.46	
St. period	2005				
O-Time	3.50	3.70	5.17	6.50	4.72
4weeks	2.20	2.82	5.14	5.75	3.98
6weeks	1.50	1.82	3.98	5.40	3.18
Mean	2.40	2.78	4.76	5.88	

Table 8. Effect of pulsing solutions and storage period at 0°C on chlorophyll b percentage of *Dianthus caryophyllus*, Linn. cv. Banyas during the two seasons of 2004 and 2005.

Treatments	Cont.	STS	Jas1	Jas2	Mean
St. period	2004				
O-Time	2.85	3.10	4.88	5.10	3.98
4weeks	2.61	2.63	4.11	4.80	3.54
6weeks	2.12	2.14	3.59	4.50	3.09
Mean	2.53	2.62	4.19	4.80	
St. period	2005				
O-Time	2.61	2.78	4.10	5.88	3.84
4weeks	1.90	2.30	3.69	4.50	3.10
6weeks	1.21	1.30	3.07	4.03	2.40
Mean	1.91	2.13	3.62	4.80	

St. period :Storage period  
Control: distilled water.  
STS: silver thiosulfate 1:4mM  
Jas1: jasmine oil at 0.015 %  
Jas2: jasmine oil at 0.030 %

Table 9. Effect of pulsing solutions and storage period at 0°C on carotenoids percentage of *Dianthus caryophyllus*, Linn. cv. Banyas during the two seasons of 2004 and 2005.

Treatments	Cont.	STS	Jas1	Jas2	Mean
St. period	2004				
O-Time	5.09	3.80	2.70	2.65	3.56
4weeks	6.12	4.90	2.80	2.69	4.13
6weeks	6.50	5.41	3.08	2.75	4.44
Mean	5.90	4.70	2.86	2.70	
St. period	2005				
O-Time	3.95	3.05	1.50	1.38	2.47
4weeks	4.60	3.60	2.21	1.82	3.06
6weeks	5.85	4.15	2.70	2.81	3.88
Mean	4.80	3.60	2.14	2.00	

Table 10. Effect of pulsing solutions and storage period at 0°C on flower reducing sugars (%) of *Dianthus caryophyllus*, Linn. cv. Banyas during the two seasons of 2004 and 2005.

Treatments	Cont.	STS	Jas1	Jas2	Mean
St. period	2004				
O-Time	0.34	0.63	0.95	0.99	0.73
4weeks	0.25	0.45	0.61	0.67	0.50
6weeks	0.21	0.40	0.56	0.58	0.44
Mean	0.27	0.49	0.71	0.75	
St. period	2005				
O-Time	0.30	0.85	0.94	0.97	0.77
4weeks	0.38	0.58	0.65	0.69	0.58
6weeks	0.21	0.48	0.51	0.60	0.45
Mean	0.30	0.64	0.70	0.75	

St. period :Storage Period

Control: distilled water.

STS: silver thiosulfate 1:4mM

Jas1: jasmine oil at 0.015 %

Jas2: jasmine oil at 0.030 %

EFFECT OF SOME ETHYLENE INHIBITORS ON THE KEEPING  
QUALITY AND EXTENDING THE VASE LIFE OF CARNATION  
(*DIANTHUS 'CARYOPHYLLUS, L.)* CUT FLOWERS

Table 11. Effect of pulsing solutions and storage period at 0°C on flowers total sugars (%) of *Dianthus caryophyllus*, Linn. cv. Banyas during the two seasons of 2004 - 2005.

Treatments	Cont.	STS	Jas1	Jas2	Mean
St. period	2004				
O-Time	0.56	1.07	1.25	1.30	1.05
4weeks	0.42	0.83	1.17	1.18	0.90
6weeks	0.34	0.75	1.03	1.08	0.80
Mean	0.44	0.88	1.15	1.19	
St. period	2005				
O-Time	0.52	1.12	1.20	1.28	1.03
4weeks	0.43	0.98	1.12	1.14	0.92
6weeks	0.26	0.70	0.80	0.95	0.68
Mean	0.40	0.93	1.04	1.12	

St. period :Storage period

Control: distilled water.

STS: silver thiosulfate 1:4mM

Jas1: jasmine oil at 0.015 %

Jas2: jasmine oil at 0.030 %

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تأثير بعض المواد المثبطة للإثيلين على حفظ الجودة و إطالة عمر  
أزهار القرنفل المقطوفة

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أجرى هذا البحث في معهد بحوث البساتين بالجيزة خلال موسمي ٢٠٠٤-٢٠٠٥ على أزهار القرنفل صنف Banyas ( أزهاره بيضاء اللون) و التي تم قطفها في مرحلة ما قبل النضج (مرحلة النجمة) و قد تم إختبار تأثير غمس قواعد سيقان الأزهار لمدة ساعة في الماء المقطر ، ثيوسلفات الفضة ١ : ٤ ملليمول ، زيت الياسمين بتركيزين (٠,٠١٥ ، ٠,٠٣٠ %) حيث قسمت الأزهار إلى مجموعتين:

المجموعة الأولى: أزهار الغرفة (بدون تخزين) و قد تم وضعها في فازات بها ماء مقطر .

المجموعة الثانية: تم تخزينها تخزيناً جافاً على درجة الصفر المئوي لمدة ٤ ، ٦ أسابيع.

و من أهم النتائج التي تم الحصول عليها:

١. النسبة المئوية للفقء في الوزن زادت مع زيادة فترات التخزين.
٢. أزهار القرنفل (بدون تخزين) و الأزهار المخزنة تخزيناً جافاً على درجة الصفر المئوي لمدة ٤ أسابيع أعطت أحسن النتائج مقارنة بالأزهار المخزنة لمدة ٦ أسابيع.
٣. كانت معاملة الغمس في زيت الياسمين هي الأكثر تأثيراً في زيادة عمر الأزهار و زيادة إمتصاصها للماء و كذلك حسنت من جودة الأزهار و قللت إستنزاف محتوى السكريات و الصبغات في الأوراق بالمقارنة بالمعاملات الأخرى.