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INFLUENCE OF THE EXPOSURE TO SOME GASES ON THE PHYSIOLOGICAL ACTIVITY AND QUALITY OF BANANA FRUIT

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ABSTRACT: *Hands of pre-climacteric green fruit of banana cv. Williams were obtained from EL-Kanater EL-Khairya Experimental station during two seasons 2003 and 2004, to investigate the effect of exposure banana fruit to N_2 or Co_2 gases treatments on ripening and quality of fruits. Mature green banana fruit were exposed to pure N_2 or Co_2 for 6 and 24h then stored for up 16 days at 13°C and 20°C. Changes in weight loss, firmness, T.S.S, peel color, ethylene production, respiration rate and post harvest life were evaluated. Ripening was inhibited most effectively in fruit exposed to N_2 for 6h or Co_2 for 24h. Furthermore, exposure of banana fruit to these treatments reduced the rates of ethylene production and respiration and maintained fruit quality (reduced weight loss, retards softening with reduced color development during extended periods of storage at 13°C or 20°C. These results suggest that this treatment is a feasible technology to inhibit ripening and extend the shelf life of banana fruit.*

Key words: *Pomology – banana – N2 and Co2 gases exposure – Quality parameters*

INTRODUCTION

Exposure of harvested fruit to very low O_2 atmospheres prior to storage can extend shelf life (Ke and Kader 1992). However, Anoxic treatments act by inhibiting respiration and ethylene production by fruits and thereby delay ripening related processes (Dori *et al.*, 1995 and Pesis *et al.*, 2001).

Banana, a climacteric fruit, ripens, and decays rapidly once it reaches climacteric respiration (Jiang *et al,* 1999 and Wills *et al.,* 1990). Moreover, banana fruit ripening is stimulated by ethylene and is generally associated with a loss of the green skin color and softening of the pulp via degradation of pectin caused by pectin methyl esterase (PME) and poly glacturonase (PG) (Karikari *et al.*, 1979). Thus storage under relatively low o_2 and /or high CO_2 conditions, or exposure to N_2 or CO_2 gases have been shown to delay ripening and decay in banana fruits (Wills *et al.* 1982., 1990 and Yi *et al.*2006).

Pre climacteric bananas exposed to low O_2 took longer to ripen, when subsequently exposed to air, than fruits Kept in air alone (Wills *et al.* 1982). However, in simulated transport trails, showed that controlled atmosphere stored bananas had higher firmness values and lower soluble solids contents for the first 3 days subsequent ripening, with no effect on peel color

(Madrid and Lopez , 1998). Furthermore, banana fruit which had been initiated to ripen by exposure to exogenous ethylene, then immediately stored in 1% O_2 at 14°C, remained firm and green over a 28 days storage period, but strated to ripen almast immediately when transferred to air at 12°C (Liu 1976). Therefore exposure of bananas fruit to pure N_2 gas for 9 hour was most effective in delaying the onset of fruit ripening, as evidenced by peel color and extended shelf life (Yi *et al.*2006).

The objective of this study was to investigate the effect of exposure pre climacteric bananas fruit to N_2 or Co_2 gases on ripening delay and to maintain the quality of fruits.

MATERIALS AND METHODS

Hands of pre- climacteric green fruit of bananas cv. Williams were obtained from El-Kanater El- Khairya Experimental Station, Kalubia Governorate during two successive seasons 2003 and 2004 and fruit handling transported to the laboratory at Hort. Res. Inst. in Giza. Hands were separated into individual fruit and sorted for the absence visual defects, for uniformity in size and weight. Approximately 1kg (10 fiugers) were placed inside a 5 L glass jar and flushed with 100% N_2 gas or carbon dioxide gas separately. The jars were sealed and stored for 0 (control), 6 hour or 24 hour at 20°C. either N_2 or Co_2 treatment. Each treatment consisted of six jars. After removal from the jars, half of them kept in cold storage at 13°C and 90% RH for 16 day while the other half were kept at 20°C and 90% RH for 16 days. Samples were taken from there replications for each treatment and examined every 4 days intervals.

The following properties were estimated.

1- weight loss percentage.
2- Fruit firmness it was measured by a hand pressure tester (Italian model) expressed in kg/cm^2 (Abbott *et al.*, 1976).
3- Total soluble solids percentage was determined by digital refractometer of "Model Abbe Leica"
4- Acidity: percentage in pulp acidity was measured by titration with 0.1 NaoH and calculated as malic acid according to A.O.A.C (1990).
5- Peel color. These parameters were measured by a tristimulus Hunter colorimeter (Model Dp 9000) and calculating the percentage ' a/b' as a color indicator, according to (Samia and Gihan, 2002).
6- Respiration rate and Ethylene value determination in fruit. One-kilogram fruits were sealed inside a 5L glass Jar for an hour at 29°C. the Co_2 concentration was determined by Dual trak model 902D gas analyzer and expressed by ml/kg/hr and Ethylene content was determination by ethylene analizer and expressed by Ul/ Kg/hr.

Statistical analysis of data was conducted according to Snedecor and Cochran (1980)

RESULTS AND DISCUSSION

1-Weight loss:

With respect to weight loss percentage during storage period data in Tables (1&2) indicate that weight loss of banana fruits increased considerably and consistently with the prolongation of the storage period. Similar conclusions have been reported by (El- Sayed, 1996 ; Allam and Elizabeth 1998) on banana. Also, was revealed that banana fruit which has been exposure to gases during storage at 20°C showed the higher percentage of weight loss compare with stored at 13°C.As known, the continuous weight loss during storage as due to evaporation and respiration (Wills *et al.*, 1981), lower temperature reduced the rate of these two physiological processes and hence decreased the speed of this character.

Data showed that there was a significant effect of fruit exposure to gases on weight loss percentage during storage at 13°C or 20°C, it appears that the percentage of weight loss was decreased with the increasing of exposure periods for Co_2 gas and decreasing exposure period for N_2 gas. However, treatment with pure N_2 gas for 6 hours or Co_2 for 24 hours was the most effective in reducing weight loss when compared with the other treatments. In addition, control fruit that did not receive any N_2 or Co_2 gave higher percentage of weight loss, similar, but less pronounced effect of anoxia treatment was observed in fruit exposed to N_2 for 24 hour and Co_2 for 6 hour. These results might be attributed to pre storage treatments of banana fruit with N_2 or Co_2 gases inhibited ethylene production and respiration rates (Ahmed and Thompson 2006 ; Yi *et al.*, 2006), which diminished the weight loss in fruit during storage.

Table (1): Effect of the exposure to N_2 or Co_2 gases on weight loss percentage of banana fruit during storage at 13°C.

Treatment	Storage period in days					Storage period in days				
	4	8	12	16	Mean	4	8	12	16	Mean
	2003					2004				
N2/ 6h	0.4	2.4	3.7	4.2	2.68	0.6	2.2	3.5	4.5	2.70
N2/ 24h	0.8	2.9	4.0	4.7	3.10	0.7	2.7	3.9	4.9	3.05
Co2/6h	1.1	3.1	4.2	4.9	3.33	0.9	3.1	4.2	5.4	3.40
Co2/24h	0.6	2.7	3.8	4.5	2.90	0.6	2.5	3.7	4.8	2.90
Control	1.5	3.7	4.7	5.8	3.93	1.7	4.1	5.2	6.3	4.33
Mean	0.88	3.00	4.08	4.82		0.90	2.92	4.10	5.18	

L.S.D at 5%

Treatment (T)	0.21	0.19
Storage period (S)	0.19	0.14
T x S	0.41	0.31

Table (2): Effect of the exposure to N_2 or Co_2 gases on weight loss percentage of banana fruit during storage at (20°C Shelf life).

Treatment	Storage period in days					Storage period in days				
	4	8	12	16	Mean	4	8	12	16	Mean
	2003					2004				
N_2/ 6h	1.7	4.0	7.3	11.2	6.05	1.5	3.9	8.1	11.0	6.13
N_2/ 24h	2.0	4.6	8.7	11.9	6.80	2.1	4.9	9.4	12.2	7.15
Co_2/6h	2.3	5.0	9.0	13.3	7.40	2.7	5.3	9.3	13.4	7.68
Co_2/24h	1.9	4.2	8.0	11.4	6.38	1.7	3.8	8.3	11.5	6.33
Control	3.0	6.1	10.7	13.7	8.38	3.2	7.0	11.5	14.1	8.95
Mean	2.18	4.78	8.74	12.30		2.24	4.98	9.32	12.44	

L.S.D at 5%

Treatment (T)	0.26	0.18
Storage period (S)	0.16	0.14
T x S	0.41	0.24

The interaction between exposure gases and storage period on weight loss showed significant effect on both seasons.

2- Fruit firmness:

Data in tables (3&4) presented that banana fruits before storage were firmer than at storage period. Also, there was a significant reducing in fruit firmness by the prolongation of storage periods in both seasons (Allam and Elizabeth 1998). The decline in fruit firmness may be due to the gradual breakdown of protopectin to lower molecular weight fractions which are more soluble in water and this was directly correlated with the rate of softening of the fruits (Wills *et al.* 1981). From the same data it is obvious that fruit firmness was affected by storage at 13°C and 20°C (shelf life). The highest values of firmness comparatively resulted from fruits stored at 13°C and the lowest ones came from storage at 20, this may be due to lower temperature led to a depression in the vital physiological and biochemical reactions in the fruits, which in turn maintaining fruit firmness.

Concerning the effect of fruit exposure to gases on fruit firmness during cold storage at 13°C and 20°C, data revealed that banana fruit exposed to N_2 and Co_2 gases exhibited delayed fruit softening relative to control fruit, whereas the highest firmness of fruits was obtained from fruits exposure to N_2 for 6 hour followed by CO_2 for 24 hour with significant differences between them, while fruit exposed to N_2 for 24 hour were less effective in maintaining fruit firmness. These results could be attributed to fruit exposed to N_2 gas exhibited delayed and lower peaks of pectin methyl esterase (PME)

and poly glacturonase (PG) activities, which are consistent with the delayed onset of the ethylene climacteric and this in turn maintaining fruit firmness (Yi *et al.* 2006).

Table (3): Effect of the exposure to N_2 or CO_2 gases on firmness (kg/cm^2) percentage of banana fruit during storage at 13°C.

Treatment	Storage period in days						Storage period in days					
	0	4	8	12	16	Mean	0	4	8	12	16	Mean
	2003						2004					
N_2/ 6h	12.3	4.2	2.9	2.6	0.4	4.48	11.8	5.6	4.6	2.2	0.3	4.90
N_2/ 24h	12.3	3.6	2.4	0.6	0.1	3.80	11.8	3.8	2.1	0.9	0.1	3.74
Co_2/6h	12.3	3.1	1.8	0.4	0.1	3.54	11.8	3.6	1.9	0.9	0.1	3.66
Co_2/24h	12.3	3.9	2.8	1.2	0.3	4.10	11.8	4.4	4.0	2.2	0.2	4.52
Control	13.3	2.8	1.0	0.3	0.1	3.50	1.8	2.8	1.8	0.4	0.1	3.38
Mean	12.50	3.52	2.18	1.02	0.20		11.80	4.04	2.88	1.32	0.16	

L.S.D at 5%

Treatment (T)	0.21	0.19
Storage period (S)	0.11	0.14
T x S	0.27	0.23

Table (4): Effect of the exposure to N_2 or CO_2 gases on firmness (kg/cm^2) percentage of banana fruit during storage at (20°C shelf life).

Treatment	Storage period in days						Storage period in days					
	0	4	8	12	16	Mean	0	4	8	12	16	Mean
	2003						2004					
N_2/ 6h	12.3	2.8	1.3	0.8	0.1	3.46	11.8	2.4	1.0	0.9	0.1	3.24
N_2/ 24h	12.3	2.2	1.0	0.3	0.1	3.18	11.8	1.8	0.8	0.4	0.1	2.98
Co_2/6h	12.3	1.9	0.8	0.2	0.1	3.06	11.8	1.4	0.6	0.2	0.1	2.82
Co_2/24h	12.3	2.5	1.1	0.6	0.1	3.32	11.8	2.0	0.9	0.6	0.1	3.08
Control	12.3	1.6	0.9	0.3	0.1	3.04	11.3	1.0	0.6	0.4	0.1	2.68
Mean	12.30	2.20	1.02	0.44	0.10		11.80	1.72	0.78	0.50	0.10	

L.S.D at 5%

Treatment (T)	0.25	0.21
Storage period (S)	0.19	0.16
T x S	0.32	0.30

3 -Total Soluble Solids (TSS):

Presented data in Tables (5&6) indicated that T.S.S percent increased gradually with prolongation storage period in all treatments, the increase in T.S.S. during storage might owe to the conversion of complex compounds to sugars (Kader *et al.* 1994). However, when we have a look to the different storage temperatures it can be possible to detect that banana fruits in the higher temperature (20°C) obtained T.S.S. content more than those kept in lower temperature at 13°C in all treatments used. These results could be related to the slowing down of ripening process during storage at 13°C.

Also, data revealed that the results of T.S.S. content changes during storage at 13°C or 20°C as affected by the different treatment. There were clear evidences that the percent of T.S.S. was highest content in control treatment than banana fruit exposure to N_2 or Co_2. when the different treatment were put in comparison it could be conclude that treatment with pure N_2 gas for 6 hours or Co_2 for 24 hours was the most effective in reducing T.S.S. content. These results might be attributed that pre- storage treatment of banana fruit with N_2 or Co_2 gases are considered to reduce the rates of ethylene production and respiration by inhibiting ACC oxides activity (Yi *et al.* 2006). Which reduce T.S.S content.

The interaction between exposure gases and storage period on T.S.S showed significant effect during all storage periods at 13°C or 20°C.

Table (5): Effect of the exposure to N_2 or Co_2 gases on T.S.S. percentage of banana fruit during storage at 13°C.

Treatment	Storage period in days						Storage period in days					
	0	4	8	12	16	Mean	0	4	8	12	16	Mean
	2003						2004					
N_2/ 6h	3.5	10.2	12.0	13.6	14.5	1076	3.4	9.9	11.1	12.6	13.6	10.12
N_2/ 24h	3.5	11.0	13.2	14.6	16.1	11.68	3.4	10.1	12.0	13.7	15.2	10.88
Co_2/6h	3.5	11.6	13.6	14.8	16.4	11.98	3.4	10.3	12.2	13.9	15.6	11.08
Co_2/24h	3.5	11.4	13.0	14.0	14.9	11.36	3.4	10.0	11.9	12.9	14.9	10.62
Control	3.5	12.0	14.8	15.6	17.2	12.62	3.4	11.4	13.4	14.9	16.3	11.88
Mean	3.50	11.40	13.32	14.52	15.82		3.40	10.34	12.12	13.60	15.12	

L.S.D at 5%

Treatment (T)	0.18	0.22
Storage period (S)	0.15	0.15
T x S	0.26	0.32

Table (6): Effect of the exposure to N_2 or Co_2 gases on T.S.S. percentage of banana fruit during storage at (20°C Shelf life).

Treatment	Storage period in days					Mean	Storage period in days					Mean
	0	4	8	12	16		0	4	8	12	16	
	2003						2004					
N_2/ 6h	3.5	12.7	14.2	16.7	17.5	12.92	3.4	13.9	15.1	17.0	17.6	13.40
N_2/ 24h	3.5	13.2	15.4	17.5	18.4	13.60	3.4	14.1	15.6	17.7	18.2	13.80
Co_2/6h	3.5	14.0	16.0	18.5	19.1	14.22	3.4	15.3	16.2	18.0	18.4	14.26
Co_2/24h	3.5	13.0	14.8	17.0	18.1	13.28	3.4	13.9	15.0	17.5	17.9	13.54
Control	3.5	15.4	16.8	19.1	21.2	15.20	3.4	15.4	16.0	18.2	20.3	14.66
Mean	3.50	13.66	15.44	17.76	18.86		3.40	14.52	15.58	17.68	18.48	

L.S.D at 5%

Treatment (T)	0.21	0.20
Storage period (S)	0.17	0.16
T x S	0.37	0.30

4 - Titratable acidity

From the results in tables (7&8) showed that the titratable acidity in the tissues of banana fruits decreased gradually during storage. The banana fruits acidity suffered marked changes during their storage period.

Data revealed that there were significant effects of exposure_gases on titratable acidity during storage at 13°C or 20°C (shelf life). Titratable acidity increased with the increasing exposure period for Co_2 gas and decreasing exposure period for N_2 gas. The exposure period for 6 h to N_2 gas and 24h to Co_2 were the most effective in maintaining titratable acidity when compared with the other treatments. However, control treatment had the lowest significant acidity compared to all tested treatments.

Maintaining higher acidity of Williams banana fruit during storage might be convenient in the view of results obtained by (EL-Sayed 1996) who noted that modified atmosphere maintain a higher titritable acidity in banana fruit during 20 weeks storage period.

Concerning the effect of the interaction between exposure gases and storage period on the acidity content of banana fruits, data showed that exposure period for 6h to N_2 gas had the highest value after 16 days of storage at 13°C or 20°C (shelf life).

Table (7): Effect of the exposure to N_2 or Co_2 gases on titratable acidity percentage of banana fruit during storage at 13°C.

Treatment	Storage period in days						Storage period in days					
	0	4	8	12	16	Mean	0	4	8	12	16	Mean
	2003						2004					
N_2/ 6h	0.37	0.35	0.23	0.20	0.15	0.26	0.38	0.35	0.31	0.28	0.26	0.32
N_2/ 24h	0.37	0.30	0.25	0.16	0.11	0.24	0.38	0.33	0.26	0.21	0.16	0.27
Co_2/6h	0.37	0.30	0.20	0.13	0.10	0.22	0.38	0.32	0.28	0.21	0.15	0.27
Co_2/24h	0.37	0.35	0.22	0.19	0.16	0.26	0.38	0.34	0.30	0.26	0.21	0.30
Control	0.37	0.25	0.20	0.13	0.08	0.21	0.38	0.28	0.25	0.15	0.10	0.23
Mean	0.37	0.31	0.22	0.16	0.12		0.38	0.32	0.28	0.22	0.18	

L.S.D at 5%

Treatment (T)	0.02	0.02
Storage period (S)	0.01	0.02
T x S	0.03	0.04

Table (8): Effect of the exposure to N_2 or Co_2 gases on titratable acidity percentage of banana fruit during storage at (20°C shelf life).

Treatment	Storage period in days						Storage period in days					
	0	4	8	12	16	Mean	0	4	8	12	16	Mean
	2003						2004					
N_2/ 6h	0.37	0.35	0.29	0.26	0.20	0.29	0.38	0.31	0.28	0.22	0.18	0.27
N_2/ 24h	0.37	0.30	0.21	0.20	0.16	0.25	0.38	0.25	0.21	0.18	0.15	0.23
Co_2/6h	0.37	0.28	0.20	0.16	0.13	0.23	0.38	0.23	0.17	0.14	0.12	0.21
Co_2/24h	0.37	0.33	0.26	0.23	0.18	0.27	0.38	0.27	0.26	0.20	0.16	0.25
Control	0.37	0.29	0.18	0.15	0.12	0.22	0.38	0.22	0.14	0.13	0.08	0.19
Mean	0.37	0.31	0.23	0.20	0.16		0.38	0.26	0.21	0.17	0.14	

L.S.D at 5%

Treatment (T)	0.02	0.02
Storage period (S)	0.01	0.01
T x S	0.04	0.03

5 - Peel color

Data presented in tables (9&10) reveal that, in green color of banana fruits during storage diminished gradually with the elapse of the storage period Table (9&10). This gradually decrement in chlorophyll contents significantly occurred in these fruits with prolongation storage period.

The decrease in green color with storage may be due to the destruction of chlorophyll and transformation of chloroplasts to chromoplasts. This might be attributed to the activity of enzymes.

Untreated fruit lost their green color more than all treatment either in cold storage or ambient condition. This disappearance of green color was not the same in various applied treatments. It obvious from the data that there was significantly more green color in the peel of fruit that had been stored at cold storage (13°C) and exposure to N_2 for 6h or Co_2 for 24h. Fruits exposure to N_2 gas for 24h or Co_2 gas for 6h were in between. These results are in harmony with results obtained by Ahmad and Thompson 2006.

Also, these reductions of green color were higher in fruit stored at 20°C than those stored at 13°C.

Concerning the interaction between various treatments application and storage period results showed significant effect for banana fruit in both seasons.

Table (9): Effect of the exposure to N_2 or CO_2 gases on peel color (a/b value) of banana fruit during storage at 13°C.

Treatment	Storage period in days						Storage period in days					
	0	4	8	12	16	Mean	0	4	8	12	16	Mean
	2003						2004					
N_2/ 6h	0.69	0.53	0.44	0.29	0.18	0.43	0.65	0.5	0.46	0.28	0.15	0.42
N_2/ 24h	0.69	0.44	0.36	0.26	0.14	0.38	0.65	0.42	0.34	0.24	0.13	0.37
Co_2/6h	0.69	0.42	0.32	0.23	0.13	0.36	0.65	0.43	0.32	0.23	0.12	0.35
Co_2/24h	0.69	0.52	0.4	0.25	0.17	0.41	0.65	0.49	0.35	0.27	0.14	0.39
Control	0.69	0.32	0.33	0.07	0.07	0.30	0.65	0.3	0.21	0.1	0.06	0.28
Mean	0.69	0.45	0.37	0.22	0.14		0.65	0.43	0.34	0.22	0.12	

L.S.D at 5%

Treatment (T)	0.06	0.05
Storage period (S)	0.06	0.04
T x S	0.10	0.07

Table (10): Effect of the exposure to N_2 or CO_2 gases on peel color (a/b value) of banana fruit during storage at (20°C shelf life).

Treatment	Storage period in days						Storage period in days					
	0	4	8	12	16	Mean	0	4	8	12	16	Mean
	2003						2004					
N_2/ 6h	0.69	0.44	0.3	0.18	0.11	0.34	0.65	0.4	0.28	0.16	0.1	0.33
N_2/ 24h	0.69	0.4	0.26	0.16	0.08	0.32	0.65	0.36	0.24	0.14	0.08	0.31
Co_2/6h	0.69	0.38	0.26	0.15	0.06	0.31	0.65	0.34	0.25	0.13	0.07	0.30
Co_2/24h	0.69	0.42	0.27	0.17	0.1	0.33	0.65	0.38	0.28	0.17	0.09	0.32
Control	0.69	0.31	0.26	0.09	0.01	0.27	0.65	0.29	0.22	0.08	0.01	0.26
Mean	0.69	0.39	0.27	0.15	0.07		0.65	0.35	0.25	0.14	0.07	

L.S.D at 5%

Treatment (T)	0.07	0.07
Storage period (S)	0.05	0.04
T x S	0.11	0.10

6 – Ethylene

Data in tables (11&12) and Fig (1/A) revealed that the N_2 or Co_2 treatment induced delay in fruit ripening was generally accompanied by a reduction in the rates of ethylene production. Treatments with N_2 and Co_2 delayed the onset of the climacteric peak of ethylene by 4 days relative to control fruit either in cold storage or ambient conditions. Similar results were obtained by (Pesis *et al* . 2001 and Wills *et al.* 1982), by applying low O_2 . low O_2 atmosphere are considered to reduce the rates of ethylene production and respiration by inhibiting ACC oxidaes activity (Stow *et al* 2000). Also, data presented that banana fruit exposure gases during storage at 13°C showed lower rate of ethylene production compare with fruit stored at 20°C. These results meight be attributed that lower temperature reduced the rate of respiration (Wills *et al.*, 1990).

7 - Respiration rate:

Data presented in tables (13&14) and Fig (1/B) reveal that, in cold storage (13°C), the level of Co_2 progressively and consistently increased with the prolongation of storage and reached its peak at the end of storage period in all treatments except control treatment which reached its peak after 12 days from storage. However, in ambient conditions (20°C), respiration rates in various treatment increased with the prolongation of storage and reached its peak after 12 days, then decreased till the end of storage, while, control treatment reached its peak after 8 days from storage, then decreased till the end of storage period.

Table (11): Effect of the exposure to N_2 or Co_2 gases on ethylene (Ul/kg/hr) of banana fruit during storage at 13°C.

Treatment	Storage period in days						Storage period in days					
	0	4	8	12	16	Mean	0	4	8	12	16	Mean
	2003						2004					
N_2/ 6h	0.1	0.3	0.7	1.1	1.6	0.76	0.1	0.2	0.8	1.3	1.9	0.86
N_2/ 24h	0.2	0.4	0.9	1.3	1.9	0.94	0.2	0.3	0.9	1.5	2.0	0.98
Co_2/6h	0.3	0.4	1.0	1.4	1.9	1.00	0.2	0.4	1.0	1.5	2.0	1.02
Co_2/24h	0.2	0.3	0.8	1.2	1.8	0.86	0.3	0.3	0.9	1.4	1.9	0.96
Control	0.4	0.6	1.2	1.8	1.3	1.06	0.4	0.7	1.4	1.9	2.2	1.32
Mean	0.24	0.40	0.92	1.36	1.70		0.24	.38	0.10	1.52	2.00	

L.S.D at 5%

Treatment (T)	0.10	0.08
Storage period (S)	0.08	0.06
T x S	0.20	0.11

Table (12): Effect of the exposure to N_2 or CO_2 gases on ethylene (Ul/kg/hr) of banana fruit during storage at (20°C shelf life).

Treatment	Storage period in days						Storage period in days					
	0	4	8	12	16	Mean	0	4	8	12	16	Mean
	2003						2004					
N_2/ 6h	0.1	0.4	1.0	1.5	1.2	0.84	0.1	0.5	1.1	1.7	1.4	0.96
N_2/ 24h	0.2	0.5	1.3	1.6	1.2	0.96	0.2	0.6	1.4	1.5	1.4	1.02
Co_2/6h	0.3	0.6	1.4	1.7	1.3	1.06	0.2	0.6	1.4	1.7	1.4	1.06
Co_2/24h	0.2	0.5	1.2	1.6	1.3	0.96	0.3	0.5	1.3	1.7	1.2	1.00
Control	0.4	0.8	1.7	1.4	1.3	1.20	0.4	0.9	1.8	1.3	1.0	1.08
Mean	0.24	0.56	1.32	1.56	1.34		0.24	0.62	1.40	1.58	1.28	

L.S.D at 5%

Treatment (T)	0.07	0.09
Storage period (S)	0.04	0.06
T x S	0.11	0.13

Table (13): Effect of the exposure to N_2 or CO_2 gases on CO_2 emission (mg/kg/hr) of banana fruit during storage at 13°C.

Treatment	Storage period in days						Storage period in days					
	0	4	8	12	16	Mean	0	4	8	12	16	Mean
	2003						2004					
N_2/ 6h	1.0	4.0	8.0	11.0	13.0	7.40	1.0	3.0	7.0	10.0	14.0	7.00
N_2/ 24h	2.0	6.0	11.0	14.0	17.0	10.00	3.0	6.0	11.0	14.0	18.0	10.40
Co_2/6h	3.0	7.0	11.0	15.0	17.0	10.60	4.0	8.0	13.0	15.0	18.0	11.60
Co_2/24h	1.0	5.0	10.0	13.0	16.0	9.00	2.0	5.0	9.0	13.0	16.0	9.00
Control	4.0	8.0	14.0	18.0	13.0	11.40	4.0	10.0	14.0	19.0	14.0	12.20
Mean	2.20	6.00	10.80	14.20	15.20		2.80	6.40	10.80	14.20	16.00	

L.S.D at 5%

Treatment (T)	0.18	0.22
Storage period (S)	0.12	0.17
T x S	0.27	0.31

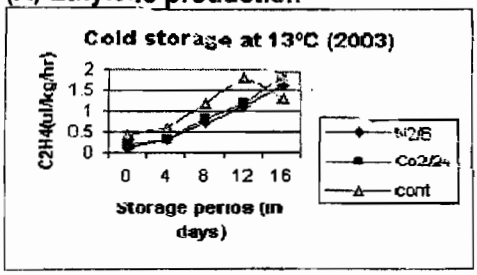
Table (14): Effect of the exposure to N_2 or CO_2 gases on CO_2 emission (mg/kg/hr) of banana fruit during storage at 20°C (shelf life).

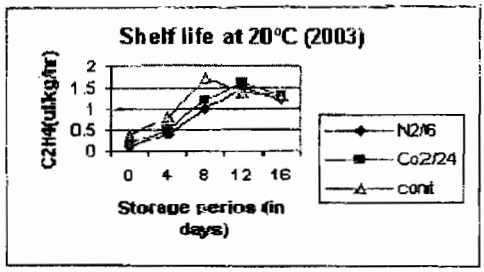
Treatment	Storage period in days						Storage period in days					
	0	4	8	12	16	Mean	0	4	8	12	16	Mean
	2003						2004					
N_2/ 6h	1.0	6.0	7.0	28.0	25.0	13.40	1.0	8.0	16.0	31.0	27.0	16.60
N_2/ 24h	2.0	9.0	20.0	27.0	25.0	16.60	3.0	12.0	15.0	32.0	28.0	18.00
Co_2/6h	3.0	10.0	23.0	28.0	24.0	17.60	4.0	14.0	17.0	33.0	26.0	18.80
Co_2/24h	1.0	7.0	10.0	27.0	24.0	13.80	2.0	10.0	13.0	29.0	25.0	15.80
Control	4.0	18.0	30.0	24.0	20.0	19.20	4.0	20.0	33.0	30.0	22.0	21.80
Mean	2.20	10.00	15.80	26.80	23.60		2.80	12.80	18.80	31.00	25.60	

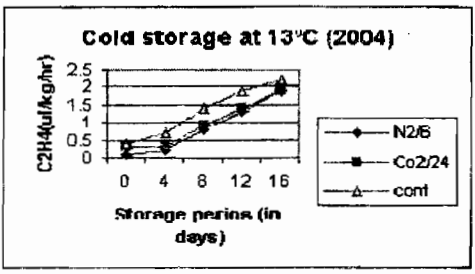
L.S.D at 5%

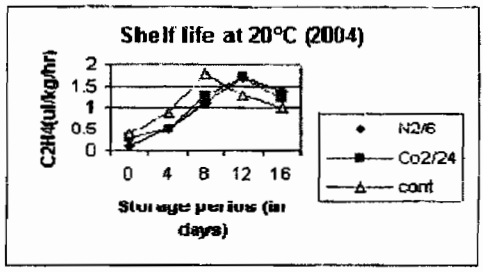
Treatment (T)	0.23	0.25
Storage period (S)	0.15	0.17
T x S	0.33	0.31

(A) Ethylene production

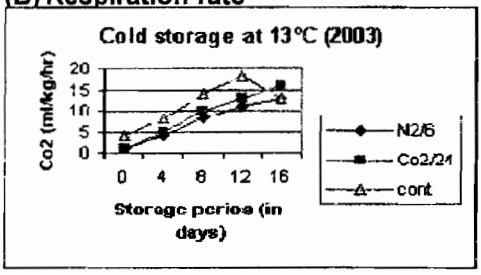


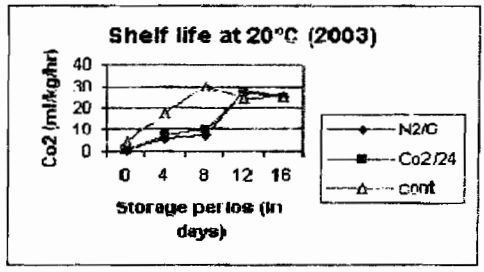


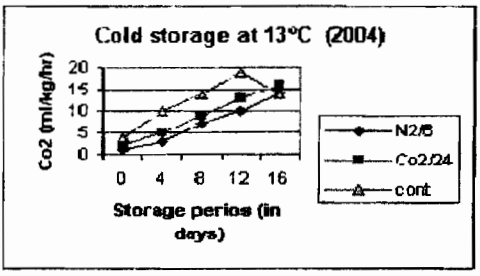




(B) Respiration rate







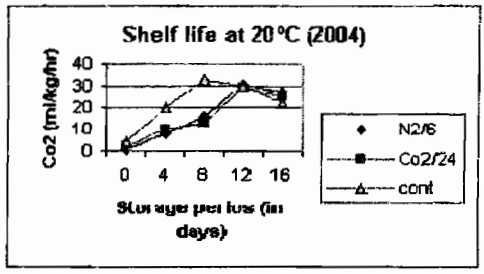


Fig (1): Changes in the rates of ethylene production and respiration of banana fruits exposed toN2 for 6h or Co2 for 24h and control.

Respiration rate of untreated fruit (control), recorded higher value during storage at 13°C or 20°C. while banana fruit exposure to N_2 and Co_2 gases are reduced the rates of respiration during storage. However, treatment with N_2 gas for 6h or Co_2 for 24h was the most effective in reducing respiration rate when compared with the other treatments either at cold storage or in ambient condition.

Similar finding have been reported by (Yi *et al.* 2006) who found that banana fruit exposure to N_2 gas reduced the rates tissues respiration. Also, data revealed that banana fruit exposure gases showed higher respiration rate during storage at ambient condition (20°C) compare with stored at cold storage (13°C). These results could be related to the high rate of anaerobic reach ions in higher temperature for such kind of respiration (Dangyan *et al.*1991).

Generally, it may be concluded that mature green banana fruit cv. Williams exposed to pure N2 for 6 h. or Co2 for 24 h. were a feasible technology to inhibit ripening and extend the shelf life of banana fruits

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تأثير استخدام بعض الغازات على النشاط الفسيولوجى والجودة لثمار الموز

هشام علام – أشرف محفوظ مشرقى
معهد بحوث البساتين – مركز البحوث الزراعية

الملخص العربى

جمعت كفوف الموز صنف وليامز في مرحلة خضراء قبل الكلايمكتريك من مزرعة القناطر الخيرية خلال موسمي ٢٠٠٣– ٢٠٠٤ لدراسة تأثير تعرض ثمار الموز لغاز النيتروجين أو ثاني أكسيد الكربون علي النضج وجودة الثمار . تم تعريض ثمار الموز الخضراء المكتملة النمو لغاز النيتروجين أو ثاني كسيد الكربون لمدة ٦ ساعات أو ٢٤ ساعة ثم خزنت لمدة ١٦ يوم علي درجة حرارة ١٣°م أو ٢٠°م . تم تقدير التغيرات التي تحدث أثناء التخزين (فقد الوزن – الصلابة – .T.S.S – لون القشرة – إنتاج الأثلين – معدل التنفس) .

وقد وجد أن تعرض الثمار للنيتروجين لمدة ٦ ساعات وثاني أكسيد الكربون لمدة ٢٤ ساعة كانت اكثر تأثيرا في تثبيط النضج مع حفظ صفات الجودة للثمار (تقليل فقد الوزن وتطور اللون وتأخير فقد الصلابة) خلال التخزين علي ١٣°م و ٢٠°م هذا بالإضافة إلى أن تعرض ثمار الموز إلى هذه المعاملة قد أدي إلى تقليل معدل الأثلين والتنفس . وتوصي النتائج باستخدام هذه المعاملة كتكنولوجيا متاحة لتثبيط النضج و إطالة فترة حياة ثمار الموز خلال عرضها بالأسواق.