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EFFECT OF SMART PACKAGING ONPHYSICAL AND CHEMICAL CHARACTERISTICS ON DATE PALM CULTIVAR ZAGHLOUL

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ABSTRACT

The present study was carried out during the two successive seasons (2016 and 2017) on date palm fruits (Zaghloul date) to investigate the effect of some types ofpassive modified atmosphere packaging such as (smart bags imported from Canada PrimePro® bag is a polyethylene plastic film produced to extend the shelf life of fresh fruits),microperforated low density Polyethylene bags (LDPE) and microperforatedPunnets (PET) compared with control (Carton boxes) under cold storage (4C) conditions (0±1°C with RH. 85-90%) and exposed to the ambient air (passive MAP). The quality changes of fresh fruits were studied by determining the physiochemical changes characteristics (weight loss, decay, firmness, total soluble solids content (TSS), total acidity (TA), total tannins, and respiration rate during storage period. The obtained results revealed that the percentage of fruit weight loss, decay, total soluble solids, total acidity, and TSS: were increased, however flesh firmness, and tannins contents relatively were reduced during advancing of the storage period. Fruits which stored in smart PrimePro® bags, microperforationPunnets (PET) arethe best package type compared with the other packages in physical and chemical characteristics.

Key words: Date palm, Postharvest, Packaging, Fruit quality, Cold storage.

1. INTRODUCTION

Date palm (*Phoenix dactylifera*L.), one of the ancient domestic fruit trees in the world, especially in the Middle East countries and their fruits play an important role in the nutritious pattern of many people. The total production of date fruits in Egypt amounted to 1,501,799 tons/year **(FAO, 2016).** In Egypt, many cultivars such as Zaghloul, Samany, Halaway and Hayany are grown in different regions. They are the earliest ripening varieties of soft date grown in Egypt. Zaghloul date is the most important commercial cultivar in Egypt and highly demanded in the Arab markets **(Kassem et al., 2011).** The process of storing dates may be necessary, since the marketing of dates according to market requirements and for a period longer than normal season, achieving a good return (**Omaima et al., 2012**) and the optimal temperature to store the fruits of dates is from 0 – 4 ^{o}C and relative humidity 85-90 % **(Al-Redhaiman, 2005)** to be stored for a month depending on the cultivar. The development and use of alternative postharvest control options involving natural plant extracts have become important, since it is perceived as being environmentally safer and more acceptable to the general

public **(Janisiewicz and Korsten, 2002)**. Recently, researchers have shown an interest in the application of packaging system should maintain the optimal storage, transport, and handling throughout the market chain for a specific commodity**, (Abdullah,etal., 2015)**

The main goal of this work was to study the effect of using some types of Passive MApackaging materials to preserve the quality of Zaghlol date palm fruits under cold conditions.

2. MATERIALS AND METHODS

2.1. Materials

Date palm (Phoenix dactylifera L.) fruits cv. Zaghloul were harvested at mid-September during two successive seasons (2016 and 2017). Fruits were harvested at maturity stage from fourteen years old palms that similar in growth and received common horticultural practices from a private orchard at Abo-Rawash region, El-Giza Governorate, Egypt. Fruits were uniform in size, appearance, free from visible physical and pathological defects. Fruits were transported to the laboratory of Agricultural Development System (ADS) project, Cairo University. Fruits were thoroughly washed with chlorine water for 3-5 minutes as sanitizing agents for inhibiting micro-spoilage (Sapers, 2009) then washed with tap water only and left to dry completely aerobically

(Packaging Materials)

Date palm fruits Zaghloul were packaged using three types of application packages

1- Smart Prime Pro® bags (dimension of (25* 35 cm) WVP (1 gm/bag/day OTR (15 cm^3/bag/day)) with thickness 30 ± 2 µm,

2- Microperforationpunnet rigid plastic (PET) average size 420g/ punnets with dimensions of (L 15cm x W 15cm x D 8 cm), 8 pores/ punnet 20 µm, (W.V.L) Water Vapor Leakage (1 gm/punnet/day) (O.T.R) Oxygen transmission Rate (10 cm^3/punne /day),

3- Microperforation Low density polyethylene bagsdimensions (25 x 30 cm with thickness 30±2 µm, 8 pores/ punnet 20 µm WVP Water Vapor permeability 5gm/bags/day OTR 10 cm3/bag/day)

4- Carton boxes as a control. All packages (25 fruits for each package) were stored at 4±1°C, with 85-90% RH.

Three replicates for each samples of date (10 days) were used and

each replicate consisted of 15 fruits. Fruit quality measurements were assessed during storage at 0±1°C.

2.2. Fruit quality assessments:

2.2.1. Weight loss (%):

Fruits were weighed at the beginning of the experiment and every 10 days during 40 days of storage. The fruit weight loss percent was calculated by standard procedure as mentioned by (Vicente et al., 2003) following equation.

Fruit weight loss % = wt. of 1st interval – wt. of 2nd interval x100 / wt. of 1st interval.

2.2.2. Decay Incidence (%):

Fruits, which decayed by different physiological and pathological factors were periodically counted and

discarded. Then percentages of decayed fruits were calculated in relation to total number of fruits.

Decay percentage was calculated as follows:

$$\text{Decay (\%)} = a \times 100\ b$$

Where:

a = Number of decayed fruits at time of sampling.

b = Initial fruit number. Fruit firmness (Ib inch 2):

firmness was determined as Ib inch^2 by using Lefra Texture Analyser (Mod.TA1000).

2.2.3. Fruit color measurement:

Skin colorwas determined and expressed as based on the CIELAB color system (L*, a*, b*and h◦) using a Minolta Co., Ltd., Osaka, Japan). Hue angle values were calculated from a* and b* values according to the following equations: h◦ = tan -1 (b*/a*) using the methods described by (McGuire, 1992).

Total soluble solids(TSS%): Estimated in date palm fruit juice using digital hand refractometer (Model Palette, PR-32, Atago).

Total acidity (TA %):

Expressed as malic acid and determined by titrating 5 ml juice with 0.1 N sodium hydroxide using phenolphthalein as an indicator.

Total soluble solids / Total acidity ratio:was calculated by dividing TSS (%) by total acidity (%), as the methods described by (A.O.A.C., 2000).

Total tannins content (mg/g fw.):were estimated as mg per gm fresh weight due to the method described by (A.O.A.C., 2000).

Fruit over ripening percentage was calculated as follows:

$$\text{Fruit over ripening (\%)} = \frac{a \times 100}{b}$$

Where:

a = Number of Fruit over ripening at time of sampling.

b = Initial fruit number.

2.2.4. Respiration rate

Respiration rate was measured by auto gas analyzer for each analysis, date frit were placed in a container hermetically sealed with a silicone rubber septum for 2 hr. After specified time, the head-space gas particularly CO2 was sucked through a hypodermic hollow needle and the respiration rate was measured and expressed as cm3 (gas)/g.h, (Hameed, et al., 2010)

2.2.5. Statistical analysis:

All data were subjected to statistical analysis according to the procedures reported by (Snedecor and Cochran, 1980). Treatment means were compared by Duncan's multiple range tests at the 5% level of probability in the two seasons of study.

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3. RESULTS AND DISCUSSION

3.1. MAP Passive gas analysis

During the storage period of 40 days, the fruit respiration resulted in a modification of the internal atmospheres and as expected, all packages showed reduce in O_2 and an increased CO_2 level (table 1 and Fig.1). The oxygen concentration decreased sharply in the first ten days, from 21 to less than 12% and continued with a little decreasing amplitude in the following days. The final O2 concentration was less than 0.07% for all packages after 40 days storage. However, the CO2 production rate was higher at the first ten days for packages were containing 22, 18, 17 and 2 for prime pro pouch, microporforatedpunnet, micoporforated polyethylene and carton box respectively According to the O2 and CO2 curves, differences between passive Packaging kinds were seen during the transient period, then, drawing near and steady state was obtained after approximately 12 days of storage. These were in agreement with the results of **Charles et al. (2008)** for fresh endives**..**It was evident from this study that the rutab spots area (RSA) that appeared duringstorage was correlated significantly with CO2 concentration within packages. Also, when the storage period prolonged, greater part of fruits changed to rutab in bags. The gas content changed rapidly during the first ten days and then the change was slows during 40 days storage. Gases content was negligible for other packaged after 20 days of storage and the lowest value was recorded in fruit packed in (carton box) as control package which a large parts of fruit turned to rutab. Appearing rutab spots and wrinkled surface are the two main disorders restricting marketing, storage and exports of khalal dates after harvest (table 1). However, turning fruit surface color to brown considered as rutab spot, comparing obtained rutab fruits in this study, with those ripened naturally on the tree, showed some major differences. Rutab spots in the fruits coming out of storage can be described as CO2 injury similar to that reported **by Serrano et al. (2005),** for sweet cherry at high CO2 concentrations. Elevated CO2 can prove to be fruit damage, often inducing fermentation, particularly when fruit is sealed in packaging film of insufficient permeability **(Betts, 1996).**

Table (1) the effect of packaging types on gases content MAP of Zaghloul dates fruit during two seasons

Storage Period	First season												Second season											
	Prime Pro bags			Micro. P Punnet PET			Micro. P Polyethylene bags			Carton box Control			Prime Pro bags			Punnet PET			Micro. P Polyethylene bags			Carton box Control		
	O2	CO2	Eth	O2	CO2	Eth	O2	CO2	Eth	O2	CO2	Eth	O2	CO2	Eth	O2	CO2	Eth	O2	CO2	Eth	O2	CO2	Eth
0	21	0.1	0	21	0.1	0	21	0.1	0	21	0.1	0	21	0.1	0	21	0.1	0	21	0.1	0	21	0.1	0
10	12	22	0	15	18	2	16	17	3	17	2	0	13	22	0	14	19	2	16	17	3	15	2	0
20	11	23	0	14	20	4	14	22	5	19	2	1	10	22	2	15	22	5	14	22	4	19	2	2
30	11	22	1	14	21	5	15	21	5	20	2	1	13	25	2	13	20	6	15	21	5	20	2	3
40	12	23	1	15	22	6	15	23	7	20	3	1	15	25	2	16	23	6	15	23	7	20	3	2

3.2.Physical properties

3.2.1. Weight loss percentage

A glace to table (1) indicated that a fruit weight loss is directly proportional and coincided with the increase of storage duration in all packages under study of Zaghloul date palm fruit, weight loss increased as cold storage proceeded. Significant weigh cold storage. Loss reductions compared to control fruits (Carton box) were recorded for all packages at the end of storage period. Suchsignificant effect was detected throughout the whole trial in all fruits packaged with **smart prime pro bags** both investigatedseasons. On the other hand Prime Pro bags seemedto efficiency in controlling weight loss,though statistical significance was not always detected after 40 days storage, packaged with Prime pro bags, microperforationpunnet PET and polyethylene bags in the first, and second season as well as packaged with control in packaged with significantly differences.

Table (2) the effect of different packaging on Weight loss of Zaghloul dates during two seasons

Storage period	First season weight loss				Second season			
	Prime Pro bags	Micro.P Punnet PET	Micro.P Polyethylene bags	Carton box Control	Prime Pro bags	Micro.P Punnet PET	Micro.P Polyethylene bags	Carton box Control
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	3.80	4.81	5.05	16.33	3.80	4.81	5.05	14.66
20	6.52	7.60	7.46	17.76	7.50	7.90	7.86	18.08
30	8.22	9.74	10.84	22.88	9.12	9.84	10.84	23.99
40	10.45	11.06	12.45	24.25	11.15	12.00	12.45	25.93

Meanwhile, after 40 days storage, the percentage of weight loss was very low (13.20 %) for fruit packaged by smart prime pro bags in the first season and 10.99 % in the second season with significant differences. Due to the action of PrimePro® bags is a active polyethylene plastic film containing a proprietary as ethylene absorber and anti fuge additive. This additive is specially designed to remove ethylene from the air around fresh produce. As ethylene is removed, the process of ripening and decay can be slowed, dramatically extending the shelf life of fresh produce. Chantler Packages http://primepromap.com/

In addition, after 40 days storage, fruit packaged by smart prime pro bags in the first and second season showed significant lower weight loss as compared to other used packages and the control as the weight loss increased gradually during storage period. Generally, all packaged were effective in reducing the rate of weight loss percentage as compared to control (carton box). Meanwhile, the highest fruit weight loss percentage was recorded for fruit packaged in carton box

3.2.2. Firmness hardness of Zaghloul fruits

As shown to table (2), fruit firmness for all packages in this study gradually decreased by storage periods advanced in fruits unpacked in both seasons. Meanwhile, the lowest fruit firmness (11.00, 10.69) was obtained

with sample unpacked in carton box as a control packaged in the first and second seasons respectively during 40 days storage period.

Table (3) The effect of different packaging on firmness hardness of Zaghloul dates during two season

storage period	First seasonfirmness				Second season			
	Prime Pro bags	Micro.P Punnet PET	Micro .P Polyethylene bags	Carton box Control	Prime Pro bags	Micro.P Punnet PET	Micro. P Polyethylene bags	Carton box Control
0	15.76	15.76	15.76	15.76	15.35	15.35	15.35	15.35
10	15.16	15.93	15.30	15.23	15.15	14.89	15.05	14.79
20	15.00	14.63	14.00	14.96	14.92	15.15	14.85	14.99
30	13.63	14.20	13.46	13.03	14.09	14.15	14.19	13.35
40	12.60	11.33	11.40	10.56	13.32	11.32	11.15	10.69

However, the highest fruit firmness was recorded for smart packaging (Prime Pro bags) fruits (12.43) in the first season and both microperforationPunnet PET and Polyethylene bags (12.33- 11.40) packaged in the second season. There was no significant difference in all packaged under study after 40 days of storage period Fruit softening is normally attributed to the destruction of cell structure and the deterioration in cell wall composition and intracellular materials. It is a biochemical process that involves the hydrolysis of pectin and starch by enzymes, for example, wall hydrolyses. These results confirm the finding of **Mortazavi S.M.H. et al (2010).,** they found that fruit packaged with Passive Modified atmosphere almost half of the fruits to turn into low quality rutab, while the best quality and longest shelf-life of khalal fruits was gained with 5% CO2 concentration. Also, passive MAP compared with control samples, showed acceptable results by extending the shelf-life of khalal date fruits, The quality changes of fresh fruit were studied under modified atmosphere packaging date fruits was packed in barrier bags and exposed to ambient air (passive MAP and different concentrate of CO2 (5, 15, and 30 %)

3.3. Chemical properties

3.3.1. Total soluble solids (TSS %)

Data fruit in tableTotal soluble solids percentage as shown in table (3) indicated that all packages type used increased with prolonging period of fruit storage in both seasons. However, most packages of Zaghloul particularly recorded the highest values of fruit total soluble solids percentage content in the second season took nearly the same trend in the first one. In addition, after 40 days storage fruit packaged by smart Prime Pro bags in the first season and fruit packaged by microperforationPunnet PET as well as fruit packaged by Polyethylene in the second season showed significantly higher TSS % as compared to the control (carton box).

Table (4) the effect of different packaging T.S.S of Zaghloul dates during two seasons

Storage period	First season				Second season			
	Prime Pro bags	Micro. P Punnet PET	Micro. P Polyethylene bags	Control (Carton box)	Prime Pro bags	Micro. P Punnet PET	Micro. P Polyethylene bags	Control Carton box)
0	11.90	11.90	11.90	11.90	11.71	11.71	11.71	11.71
10	11.83	12.07	11.90	12.37	11.58	11.61	11.88	11.81
20	12.20	12.70	12.73	12.63	12.28	12.48	12.28	12.11
30	12.20	12.87	12.77	13.00	13.74	12.68	12.41	11.84
40	12.30	12.43	12.53	12.10	13.68	12.31	12.04	12.01

The gradual increase of total soluble solids with increase of storage period and could be due to the degradation of complex in soluble compounds like starch to simple soluble compounds like sugar which are the major component of soluble solids content in the fruits. Meanwhile, the changes increased with the progress of storage period, where it allowed the accumulation of soluble solids in fruits. Our results are in agreement with the findings of **Zuhair et al.,** 20 they found that, the total soluble solids was significantly ($P \leq 0.05$) higher in control sample as compared to Zaghloul dates fruits packaged in smart Prime Pro bags. It must be noted that the lowest TSS % was at the 10 , 20 and 30 days of storage in fruit packaged in Prime Pro bags (11.90 and 12.20). Beside this, the findings of the present study also revealed that microperforationPunnet PET packaged also lower the TSS value in comparison to Polyethylene bags fruit, which indicate that Prime Pro bags delay the softening process in fruit .

3.3.2. Titratable acidity %

Date illustrated in Tables (4) Shown decreased the storage periods and increased the lowest acidity values were obtained from the control (Cartun box) while, acidity values in packaging fruits varied among the packaging material used and from cultivar to another. In this respect Zaghloul fruits packaged in smart Prime Pro bags gave low acidity values than those obtained from fruits packaged in microperforation Punnet PET this effect was more obviously noticed in 2016 season. Where packaging Zaghloul fruits in microperforation Polyethylene lower acidity than those packaging in carton box. However, the different between all combination packages were lacking from statistical stand point in both seasons. The decrease in total acidity slightly decreases.

Table (5) the effect of different packaging on acidity of Zaghloul dates during two seasons

Storage period	First season acidity				Second season			
	Prime Pro bags	Micro. P Punnet PET	Micro.P Polyethylene	Control (Carton box)	Prime Pro bags	Micro. P Punnet PET	Micro.P Polyethylene	Control (Carton box)
0	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
10	0.22	0.22	0.13	0.13	0.22	0.22	0.22	0.15
20	0.26	0.26	0.15	0.16	0.28	0.37	0.19	0.12
30	0.19	0.22	0.22	0.12	0.22	0.22	0.24	0.15
40	0.75	0.80	0.75	0.53	0.55	0.73	0.64	0.58

3.3.3.Tannin

Data in Table (6) shown that the effect of different packaging types on a tannin of Zaghloul dates during two season Fruit tannins content decreased significantly with prolonging the storage periods in both seasons, tannins, which take part in non enzymic oxidative browning thus insoluble leuco anthocyandin decrease during storage period., and Zaghloul date fruits Prime Pro bags and microperforatdPunnet PET helped to delay ripening and preserve fruit quality.

Table (6) the effect of different packaging on Tannin of Zaghloul dates during two seasons

Storage period	First season tannin				Second season			
	Prime Pro bags	Micro. P Polyethylene Punnet PET	Micro. P Polyethylene	Control Carton box	Prime Pro bags	Micro. P Punnet PET	Micro. P Polyethylene	Control (Carton box)
0	2.67	2.67	2.67	2.67	2.51	2.51	2.51	2.51
10	1.26	1.22	1.08	1.32	1.36	1.18	1.16	1.32
20	0.78	0.80	0.68	0.74	0.78	0.78	0.78	0.78
30	0.72	0.72	0.80	0.73	0.85	0.80	0.70	0.77
40	0.63	0.67	0.65	0.61	0.65	0.64	0.57	0.60

3.3.4. Fruit decay percentage

Data in table (7) indicated that, fruit decay percentage was gradually increased as a function of cold storage period at 0 °C up to 40 days either packaged or unpackaged fruits of Zaghloul date palm under study in both seasons. Meanwhile, all packages were effective in reducing the rate of decay percentage compared to the control but the effect was more pronounced with Prime Pro bags and Rigid PET in the second season as compared with the control (carton box). However, after 40 days storage unpackaged fruits lost 18.20 and 19.58 for fruit first and second season respectively. In addition, after 40 days storage fruit with 10 Prime Pro bags was

the best followed by Rigid PET as compared with the control (carton box) in a descending order in the first season.

Table (7) the effect of different packaging on decay of Zaghloul dates during two seasons

Storage Period	First season				Second season			
	Prime Pro bags	Micro.P Punnet PET	Micro. P Polyethylene	Control Carton box	Micro.P Punnet PET	Micro. PPunnet PET	Micro. P Polyethylene	Control Carton box
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	3.17	3.60	4.17	11.73	3.87	3.90	5.00	12.53
20	5.10	5.86	6.26	20.51	5.90	6.06	7.00	19.51
30	6.50	7.16	8.08	23.10	7.00	8.16	8.98	22.10
40	10.40	11.83	12.37	35.66	11.40	12.83	13.37	34.66

However, results in the second season behaved the same as that of the first season. Generally it could notice that, all packaged were effective in reducing the rate of fruit decay at any time of storage and the control. Also, the highest fruit decay was recorded for unpackaged fruits during the two seasons. The obtained data are Prime Pro bags as modified atmosphere bags was observed on Zaghlol dates during cold storage. It was found that Zaghlol dates packaged (carton box) showed a significant ripening and therefore, decayed fast as compared to smart prim pro bags. **Also, Ali et al., 17** found that, Rigid PET enhanced the shelf life of fruit up to 40 days during storage. In addition, Prime Pro bags were the optimal concentration in controlling decay (80 %),

3.3.5. Fruit color hue angle (h^o):

Table (8) the effect of different packaging on color of Zaghlol dates during two seasons

Storage Period	First season				Second season			
	Prime Pro bags	Micro. P Punnet PET	Micro. P Polyethylene.	Control Carton box	Prime Pro bags	Micro.P Punnet PET	Micro. P Polyethylene.	Control Carton box
0	30.93	30.93	30.93	30.93	29.93	29.93	29.93	29.93
10	29.03	27.32	27.06	25.57	23.05	24.97	26.75	26.93
20	30.57	27.00	28.07	25.32	31.57	23.09	26.96	24.14
30	27.97	30.44	31.00	28.39	25.30	27.89	32.61	31.70
40	34.68	33.11	27.82	31.55	34.38	34.06	28.97	35.65

The effect of different packaging treatments on date palm cv. Zaghloul fruit color hue angle (h^o) of both seasons is presented in Table (8).The results revealed that, hue angle of fruits was significantly decreased gradually with the increasing cold storage period up to 45 days and then increased till the end of storage. Date palm fruits treated with different packaging recorded high hue angle in both seasons. On the other side, fruits packaged Prime Pro bags a significant higher hue angle (34.68) followed by Rigid PET punnet (33.11) compared with the untreated fruits (31.55) after 40 days storage. Meanwhile, Polyethylene resulted in lower value of hue angle (27.82) during the first season. While seond season hue angle with prime pro bags and rigid punnet PET and control carton box were 34.38, 3406, 35.65 respectively while was 28.97 with microporforated Polyethylene bags Concerning the interaction between passive packaging condition and storage duration, data clear that prime pro bags maintained highest value of fruit hue angle at 40 storage days during 1st season, compared with control carton box. However no significant difference in Fruit color hue angle (ho): between the first and second season in the treatment of different packaging materials.

CONCLUSIONAND RECOMMENDATIONS

It is clear from the results that Zaghloul date in Passive modified atmosphere packages had best results in Prime Pro bags, then microperforation PET punnet and microperforation polyethylene packaging for all characteristics of Zaghloul date according to the OTR of packaging and respiration rate of the fruits under cooling for preservation by minimizing oxygen concentrate in packages to reduce respiration to increase the shelf life of Zaghloul fruit during storage in local and export market

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REFERENCES

1. **Al-Redhaiman, K.N.,** 2005. Modified atmosphere fake expends storage period and maintains quality of (Barhi) date fruits. V International Post harvest Symposium, Acta Hort. 34: 682 (3210).
2. **A.O.A.C., 2000.** Association of Official Agriculture
3. Chemist. Official method of analysis. 17*th* Ed., Washington, D.C. U.S.A. pp. 490-520.
4. **Abdullah M. Alhamdan, et .al** 2015 Modeling of Respiration Rate of Fresh Date Fruits (Barhi Cultivar) Under Aerobic Conditions Journal of Advanced Agricultural Technologies Vol. 2, No. 2, December 2015
5. Hameed, R., A.U. Malik, M. Imran, A.S. Khan and S. Schoten. 2010. Effects of controlled atmosphere on storability, shelf life and quality of green slender chilies (Capsicum annuum L.). Acta Hort. 876:123-134
6. **FAO, 2016**. Food and Agriculture Organization of the United Nation. The statistics of food and agriculture organization of the United Nations. http://www.fao.org.

7. **Janisiewicz, W.J. and L. Korsten, 2002**. Biological control of postharvest diseases of fruits. Ann. Rev. Phytopathology, 40, 411- 444.
8. **Kassem, H. A.; A.K.H. Omar and M.A. Ahmed, 2011**. Response of Zaghloul date palm productivity, ripening and quality to different polyethylene bagging packageds. American-Eurasian J. Agric. Environ. Sci., 11 (5): 616-621.
9. **McGuire R.G., 1992**. Reporting of objective color measurements. Hort. Sci., 27:1254-1255.
10. **Omaima, M. Hafez; Malaka, A. Saleh and M.M. Naguib, 2012.** Quality improvement and storability of some date palm cultivars by safe postharvest treatments. Australian J. of Basic and Applied Sci., 6(3): 542-550.
11. **Sapers, G.M., 2009**. Disinfection Of contaminated produce with conventional washing and sanitiz-ing technology. In: Sapers GM, Solomon EB, Matthews KR (cds) the produce contamination problem causes and solutions. Academic, New York, pp 393-414.
12. **Snedecor, G.W. and W.G. Cochran, 1980**. Statistical Methods. 7*th* ed., Iowa Stat. Univ. Press Amer.
13. Iowa, U.S.A., pp 50.
14. **Vicente, A.R.; G.A. Martínez; A.R. Chaves and P.M. Civello, 2003.** Influence of self-produced CO2 on postharvest life of heat-packaged strawberries. Postharvest Biol. Technol. 27: 265-275.