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ATTEMPTS TO FIND BEST PREHARVEST TREATMENT REQUIRED FOR OBTAINING OPTIMUM MARKETABLE FRUITS AND ITS EFFECT ON STORAGE LIFE OF 'MANFALOUTY' POMEGRANATES : II. EFFECT OF BEST PREHARVEST TREATMENT ON POSTHARVEST STORAGE BEHAVIOUR OF FRUITS IN RELATION TO PACKAGING TYPE

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ABSTRACT

Two preharvest treatments on 'Manfoulty' pomegranate trees grown on sandy soil, i.e the best (high production with least splitting and sunburn damage) and the control treatment, were evaluated concerning their effects on fruits post harvest storage life. Fruits of both preharvest treatments in sealed or micro-perforated polyethylene bags (low density, 0.025 mm thick) were stored under refrigerating conditions. Physical and quality; fruit colour, weight loss, decay, TSS, titratable acid, ascorbic acid, tannins, total phenols and total anthocyanins; were examined at harvest time and at one-month intervals up to three months.

The obtained results revealed that storage of "Manfalouty" pomegranate can be carried for up two months. The differences between preharvest treatments were not significant. Packaging fruits in perforated polyethylene bags seamed to be more suitable than the sealed ones.

INTRODUCTION

Pomegranate (*Punica granatum* L.) is an important fruit crop in many tropical and subtropical regions of the world and it is grown especially in the moderate climates of Mediterranean countries. As production has increased, proper storage and marketing of these fruit are needed to meet the demand both in domestic and export markets. The fruits are generally harvested fully ripe with a waxy shining surface of reddish yellow or greenish red peel colour, depending on the cultivar. The major storage problem is desiccation of the fruit resulting in a brownish coloured tough peel and browning of arils. Although the peel appears to be thick, it has numerous minute openings that permit free movement of water vapour, making the fruit highly susceptible to water loss (Artes *et al.*, 1998).

However, no enough publications about post-harvest treatment, transportation and storage of pomegranates, but few studies were conducted constituting the fundamental principles for pomegranate storage. The growers keep and market the fruits for few months under natural conditions. Nevertheless, this kind of application causes a high rate of water loss and fruit decay (Onur *et al.*, 1992).

Generally pomegranate fruits are well adapted to cold storage conditions, the recommended storage temperature varied from 0 to 10°C with a shelf life ranging from 2 weeks to 7 months depending on the cultivar (Kader *et al.*, 1984; Salunke and Desai, 1986; Koksal, 1989; Gil *et al.*, 1996). However, many troubles arise during cold storage such as symptoms of brown discoloration of the skin, surface pitting, shriveling, off-flavour development and susceptibility to decay organisms and the severity of these symptoms increased with time and temperature decrease below 5° C. (Elyatem and Kader, 1984 and Artes *et al.*, 2000).

The aim of this study was to compare the storage ability of 'Manfalouty' pomegranate fruits from two preharvest treatments, the best (high production with least splitting and sunburn damage) and the control treatments in two types of polyethylene packages (Perforated or non-perforated).

MATERIAS AND METHODS

Two preharvest treatments were evaluated on 'Manfalouty' pomegranate trees (7 year) grown on a private orchard located at East Beni-Mazar, about 65 km North of Minia city. A composite sample from the experimental soil was taken and analyzed one week prior to commencing the experiment according to Wilde *et al.*, (1985) and the obtained data are given in Table 1.

Table 1: Soil analysis of the experimental orchard

Items	Values	Items	Values
Sand (%)	94.0	N %	0.016
Silt (%)	2.5	P (meq/100g)	3.00
Clay (%)	3.5	K (meq/100g)	0.26
Texture	Sand	Ca (meq/100g)	0.30
pH (1 : 2.5)	9.08	Mg (meq/100g)	0.11
E.C. mmohs/cm	0.09	Fe (ppm)	2.20
Total Salts (E.C x 640)	57.6	Mn (ppm)	1.24
$CaCO_3$ %	9.15	Zn (ppm)	0.26
O.M. %	0.091	Cu (ppm)	0.25

Two hundred and ninety seven trees uniform in vigorous as possible were selected and subjected to good and scientific management practices. The selected trees were fertilized with farmyard manure during mid December at 4 farm baskets /tree. Orchard was managed carefully concerning weed, diseases and pest control throughout the whole season. The chosen trees were pruned at the first week of January and the trunk of each tree was painted with a saturated solution of sodium bicarbonate followed by lime solution, one month later. The trees were subjected to some soil and foliar macro and micro nutrient applications in addition to use some organic materials and antioxidant treatments. Thirty-three treatments (three soils and eleven foliar application treatments) were evaluated in this regard, and each treatment was replicated three times, three trees per each.

Trees were observed for their yield and fruit's splitting and sunburn degrees as well as fruit quality. The fully mature fruits of the best treatment (BT, highest quality with least cracking) and control

treatment (CT) were stored under refrigerating conditions packaged in perforated or non-perforated polyethylene bags. Washing or post-harvest chemical treatments were not applied to the fruits.

Best treatment (BT): Each tree/year fertilized with 500g N (1.5kg ammonium nitrate), 150g P_2O_5 (1.0kg calcium superphosphate) + 75g phosphorine (Bio-fertilizer) and 360g K_2O (0.75kg potassium sulphate) and foliar sprayed four times with a solution containing kaolin, macro and micronutrients. Nitrogen and potassium were added into three equal batches during the first week of March, May and July. Calcium superphosphate fertilizer was added once in the middle of December, while phosphorine was added twice at the last week of February and again at the last week of March. Kaolin at 2%, macronutrients (1% $CaCl_2$ + 1% $MgSO_4$) and micronutrients (Chelated form of Fe, Zn and Mn (0.1, 0.1 and 0.1%) + 0.05% Boric acid & 0.05% $CuSO_4$ were applied at 1st week of May, June, July and August. Trees were sprayed till run-off using 0.1% triton-B as a surfactant.

Control treatment (CT): Each tree/year fertilized with 500g N (1.5kg ammonium nitrate), 225g P_2O_5 (1.5kg calcium superphosphate) and 360g K_2O (0.75kg potassium sulphate) and foliar sprayed till run-off at the times when best treatment was applied with normal water using 0.1% triton-B as a surfactant.

To study the effect of both pre-mentioned treatments on shelf life and fruit quality, 100 fruit (20 fruits×5 replicates per treatment, were randomly selected) were either packaged in perforated (10 holes, 1.5mm diameter on both sides) or non-perforated polyethylene bags, both of low density, 0.025 thick. The bags of fruits of both treatments (BT and CT) were stored at 5°C in the refrigerator for 12 weeks and the following characters were determined at zero time (harvest time, 1st week of September) and every 4 weeks:

Husk color components (L* Lightness, a* +red, -greenness and b* +blue, -yellowness) were determined by using colorimeter (Cole palmer, USA). Three different measurements at three equidistant points on the equatorial region of each individual fruit were assessed. Husk colour was measured as L*, or calculated as chromaticity (a^{*2} +

$b^{*2})^{0.5}$ and hue (H) angle (arc tan b^* x a^{*-1}); H: 0°= red-purple, 90°= yellow) according to Artes *et al.*, (1998).

Fruit weight loss: was calculated as % of initial weight lost.

Total decay (%): the total percentage of fruit with any visible decay was recorded. Decayed fruits in the first or second checks were removed before placing the fruit back into storage.

Juice content of total soluble solids (%) and titratable acidity (%) as g citric acid /100 ml juice).

Juice content of ascorbic acid (vitamin C) as mg /100g juice (A.O.A.C., 1985).

Juice content of tannins (%) (Ranganna, 1978).

Juice content of total phenols (mg /L juice): The Folin–Ciocalteu assay was used for the determination of total phenol content in pomegranate juices. The total phenolics were determined colorimetrically at 765nm according to Singleton and Rossi (1965) and Spanos and Wrolstad (1990). A mixture of water and reagents was used as blank. Phenolics are expressed as gallic acid equivalents. Gallic acid standards at 5 different concentrations ranging from 100 to 500 mg/L were prepared. By using these standards, the gallic acid calibration curve was obtained, and total phenolics were calculated from this curve.

Juice content of total anthocyanins (mg /100g juice): The juice sample was centrifuged at 1200 rpm for 2 min and the anthocyanin content was measured at 510 nm, using a spectrophotometer (Gill *et al.*, 1996)

Experimental design and statistical analysis: The experiment was set in a completely randomized design. Groups of five replicates of 20 fruit per treatment were used. Data were analyzed by ANOVA and the significance among treatment mean values were determined by least significant difference (LSD) at the $P<0.05$ level (Gomez and Gomez, 1984).

RESULTS AND DISCUSSIONS

Peel colour:

Lightness (L value)

Lightness is a measure of color's lightness or brightness (de Mann 1999). A gradual decrease was observed in fruit brightness of all treatments with ongoing time in cold storage (Fig. 1). The great loss of fruit brightness was recorded after three months of storage. The great loss in lightness suggest the browning of fruit pulp most likely due to chilling injury or polyphenoloxidase enzymes (de Mann 1999). Such reduction was more pronounced in fruits of non-perforated bags. This may mainly due to the great precipitation of moisture inside the non-perforated bags which negatively affected the lightness of fruits. However, no significant differance was found between both preharvest treatments, in this respect.

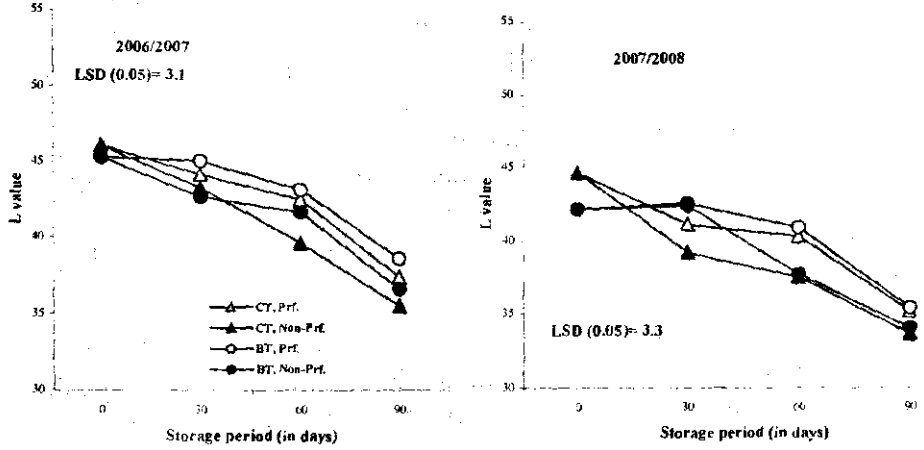

Fig 1: Peel lightness changes of pomegranate fruits during cold storage of both control (CT) and best preharvest treatments (BT) as affected by type of packages (Perforated and non-perforated bags).

Chroma value

Chroma is a measure of a color's intensity (**de Mann 1999**). Peel chroma values of all treatments had nearly the same pattern of fruit lightness (Fig. 2). Fruits in perforated bags maintained slightly more colour intensity than those in non-perforated bags. Also, control fruits fell insignificantly below those of best preharvest treatment at all measuring times. The great loss of chroma colour value was also observed after three months of storage for all tested treatments. This significant loss in chroma is an indication of loss in peel color intensity and also an indication of browning.

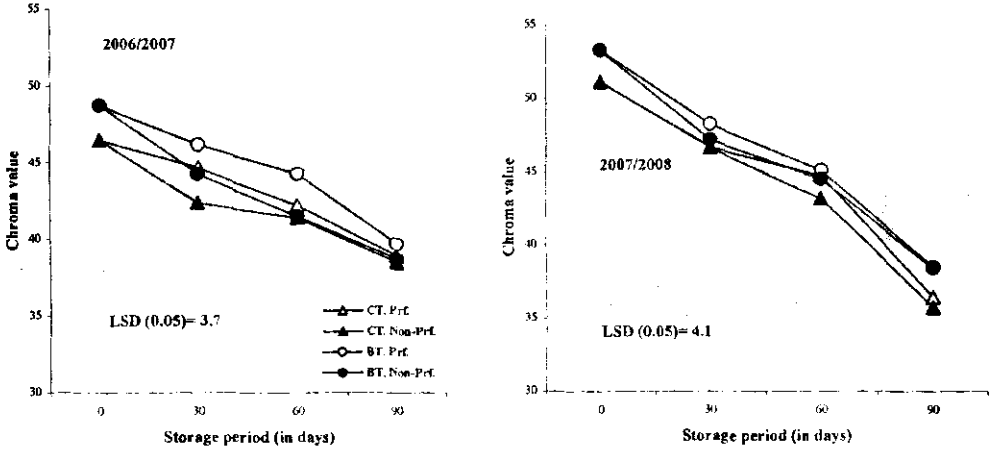

Fig 2: Peel chroma changes of pomegranate fruits during cold storage of both control (CT) and best preharvest treatments (BT) as affected by type of packages (Perforated and non-perforated bags).

Hue angle value

Hue angle is a measure of the color angle or actual color (de Mann 1999). The decrease of hue angle in pomegranate peel represents a change from green to red, while the increase represents a loss in red colour. Hue angle values of all treatments decreased reaching its minimum after two months of storage (Fig. 3). This

suggest a complete change of rind colour to red. In contrast, hue angle levels were sharply increased in all treatments particularly for fruits stored in non-perforated bags after three months periods of storage, indicating a loss of red colour due to browning. The accumulation of gases and moisture within the non-perforated bags probably enhanced senescence and quickly negated the normal colour of fruit skin. Although the red colour of control fruits was slightly better than those of best treatment at time of harvest, but greater loss was found during storage, resulting in finally better red colour for best treatment. This may be due to progressed stage of ripening for control fruits at harvest time compared with those of best treatment.

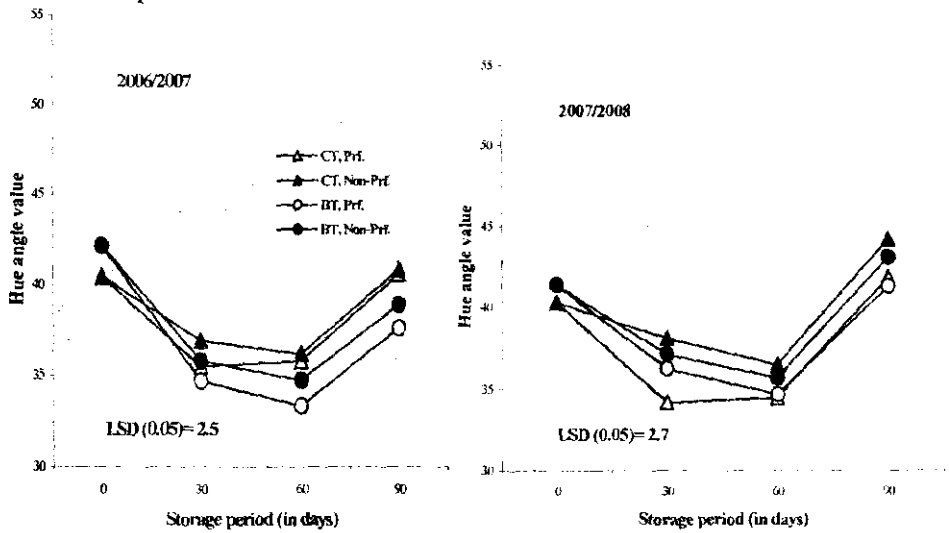

Fig. 3: Peel hue changes of pomegranate fruits during cold storage of both control (CT) and best preharvest treatments (BT) as affected by type of packages (Perforated and non-perforated bags).

Fruit weight loss

Pomegranate fruit is susceptible to water loss, probably due to numerous minute openings in the skin that permit the free movement of water vapour (Kader *et al.*, 1984 and Artes *et al.*, 1998). A

noticeable increase in fruit weight loss was observed with ongoing storage period for all treatments (Fig. 4). The large loss was recorded after three months of storage. However, no shriveling symptoms were observed at the end of storage period. This may be due to smaller weight loss values in the packages treatments. This also indicates that shriveling symptoms may need higher values of weight loss than those obtained in this experiment. Onur, (1989) reported that weight loss in pomegranate fruit, covered with plastic bags, was 0.88% whereas in the control, which was put directly into storage, ratio was 10.78%. Moreover, Nanda *et al.*, (2001) concluded that shrink film wrapping greatly reduced fruit weight loss of 'Ganesh' pomegranates. They attributed that to reduction in fruit transpiration rate by wrapping treatment. The weight loss in shrink-wrapped fruits was 1.2% against 20.4% in non-wrapped fruits after 12 weeks of storage. Accordingly, 'Manfalouty' pomegranate fruits lost greater weight when stored in perforated bags than in non-perforated bags. No significant difference was found between both preharvest treatments, in this regard.

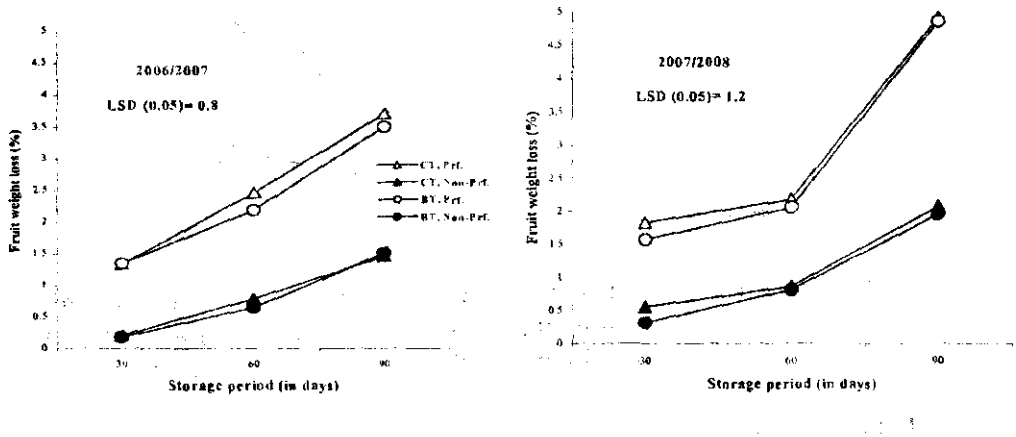

Fig . 4: Fruit weight loss of pomegranate fruits during cold storage of both control (CT) and best preharvest treatments (BT) as affected by type of packages (Perforated and non-perforated bags).

Total decay

Most observed decay of pomegranate fruits during storage are mainly due to *Penicillium sp.* (Artes *et al.*, 1998). Maximum spoilage was observed after three months of storage in all treatments (Fig. 5). Fruits did not show any decay symptoms up to two months of storage when they stored in perforated bags. However, fruits stored in non-perforated bags significantly decayed at all measuring times compared with those in perforated bags. This may be due to the modified atmosphere formed inside the non-perforated packages, which promote anaerobic activity as a result of increasing CO_2 level and decreasing O_2. The difference between both preharvest treatments was very little, in this regard, with slight more decay values for control fruits.

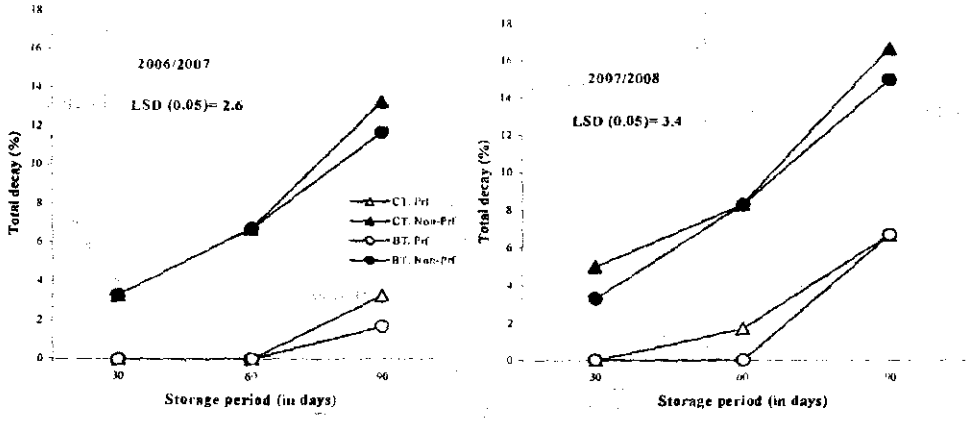

Fig. 5: Total decay of pomegranate fruits during cold storage of both control (CT) and best preharvest treatments (BT) as affected by type of packages (Perforated and non-perforated bags).

Total soluble soils :

As shown in Fig. 6, total soluble solids percentage was decreased after one month of storage compared to the value at harvest treatment. It was increased thereafter reaching similar value to that of harvest after two months of storage. Total soluble solids percentage of all treatments reached its maximum after three months of storage.

Fruits of best treatment (Each tree/year fertilized with 500g N (1.5kg ammonium nitrate), 150g P_2O_5 (1.0kg calcium superphosphate) + 75g phosphorine (Bio-fertilizer) and 360g K_2O (0.75kg potassium sulphate) and foliar sprayed four times with a solution containing kaolin, macro and micronutrients) showed lower TSS value than those of control at harvest and remained below control fruits even after three months of storage, in both seasons. This suggests that best treatment extended the shelf life of the fruits. Perforated bags resulted in higher values of TSS than non-perforated bags throughout the storage period, in both seasons.

Nanda *et al.*, (2001) stated that pomegranate, being a non-climacteric fruit of a low respiration rate, recorded a slight decrease in total sugar content during storage at different temperatures. However, the increase in juice TSS thereafter, was explained by Koksal (1989) to the loss of moisture leading to concentration of the soluble solids. The higher values of juice TSS from fruits of perforated bags than those of non-perforated bags confirm this explanation.

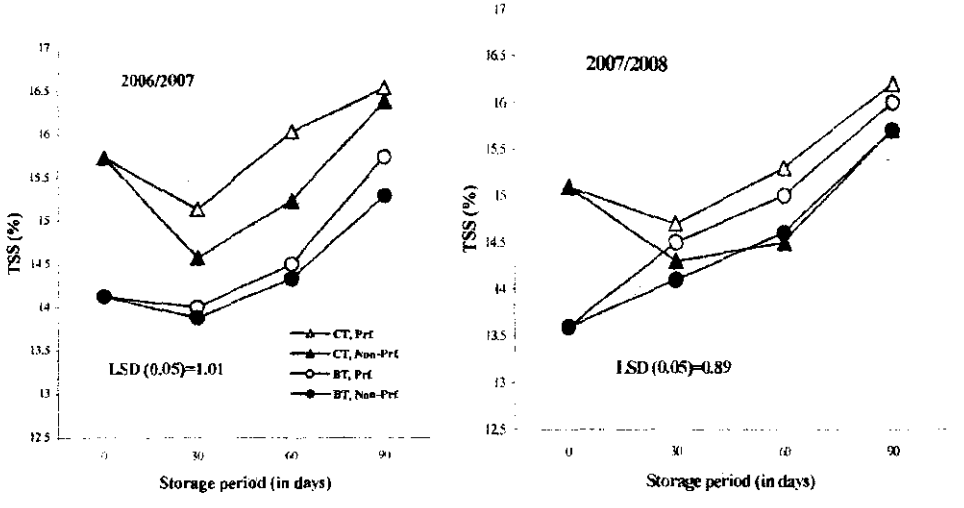

Fig. 6: Total soluble solids changes of pomegranate fruits during cold storage of both control (CT) and best preharvest treatments (BT) as affected by type of packages (Perforated and non-perforated bags).

Total acidity

Organic acids found in pomegranate included citric, malic, acetic, fumaric, tartaric and lactic acids; however, the major acid accounting for titrable acidity in pomegranate arils is citric acid (Melgarejo *et al.*, 2000). A decrease in acidity values of the fruit were observed during storage in all treatments compared with the values at harvest, and reached the minimum after three months of storage (Fig.7). Fruits of perforated bags had slightly higher values of TA than those of non-perforated bags, in the second season of the experiment. Fruits of best treatment showed higher TA value than those of control at almost all storage periods. The reduction of total acidity during storage was also observed by Koksal (1989), Waskar *et al.*, (1999) and Artes *et al.*, (2000) in different cultivars of pomegranate under different storage conditions. Due to delaying fruit ripening by using the best treatment, fruits contained lower TSS and higher TA values than those from control fruits throughout the storage periods.

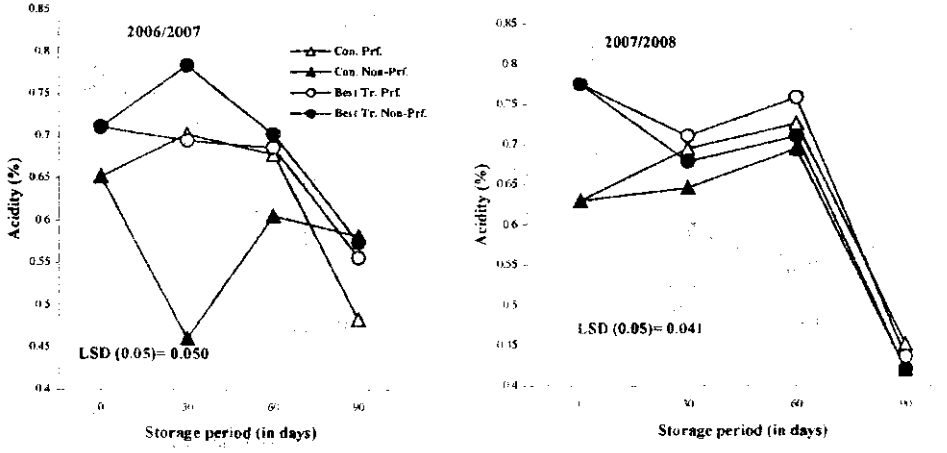

Fig. 7: Total acidity changes of pomegranate fruits during cold storage of both control (CT) and best preharvest treatments (BT) as affected by type of packages (Perforated and non-perforated bags).

Vitamin C

Vitamin C content increased slowly reaching the maximum after two months of storage, then showed a decreasing trend towards the end of storage period. Fruits of perforated bags contained more vitamin C than those of non-perforated bags especially after two months of storage. Best treatment (Each tree/year fertilized with 500g N (1.5kg ammonium nitrate), 150g P_2O_5 (1.0kg calcium superphosphate) + 75g phosphorine (Bio-fertilizer) and 360g K_2O (0.75kg potassium sulphate) and foliar sprayed four times with a solution containing kaolin, macro and micronutrients) was better than control treatment in maintaining higher values of vitamin C content (Fig. 8).

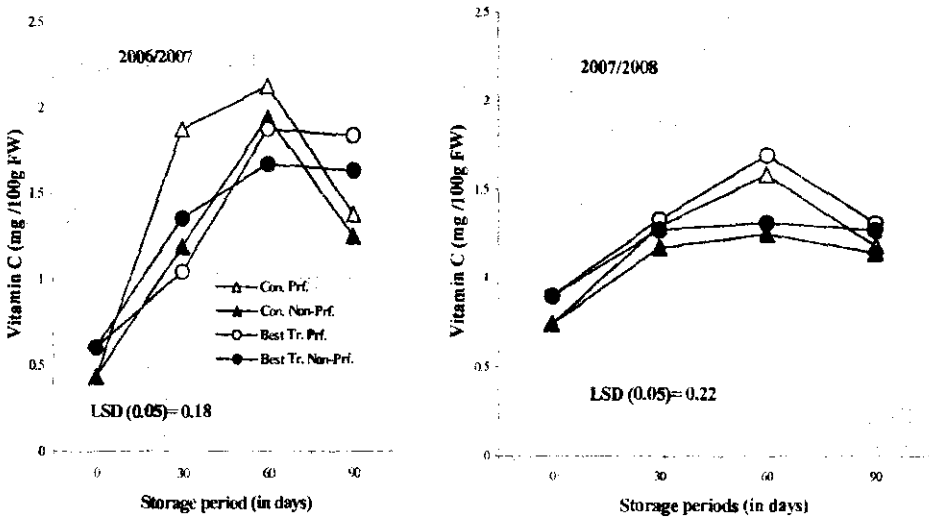

Fig. 8: Vitamin C changes of pomegranate fruits during cold storage of both control (CT) and best preharvest treatments (BT) as affected by type of packages (Perforated and non-perforated bags).

Eris and Turk (1995) recorded a slight increase in fruit content of vitamin C of pomegranates during storage and reduction after 105 days of storage. The reasons of the further reductions was attributed to the chilling injury and internal break-down especially after long time of storage. Another probable reason is the different in atmospheric atmospheric combinations in the package, likely to affect the chemical changes in the product due to the covering materials at different permeabilities This opinion is supported by the fact that ascorbic acid level was determined as the lowest with the non-perforated material having no permeability. The authors also observed higher values of vitamin C in fruits stored in high permeable packages than in those stored in packages of very limited permeability. In contrast, Koksal (1989) reported a significant gradual loss in vitamin C content in pomegranate fruits (cv. Gok Bahce) stored at higher temperatures. The difference between his and our findings may be attributed to temperature storage.

Fruits of best treatment presented higher value of vitamin C at harvest than control fruits, thereby maintained also higher values throughout the storage period.

Tannins

Tannin content showed nearly similar trend to that of vitamin C, as it was increased reaching the maximum after two months of storage, then decreased reaching the minimum at three months of storage. Fruits of perforated bags contained significant and insignificant higher tannin values than those of non-perforated bags at two and three months of storage, respectively. The difference in tannin values between best treatment and control treatment was very low especially at the end of storage period (Fig. 9).

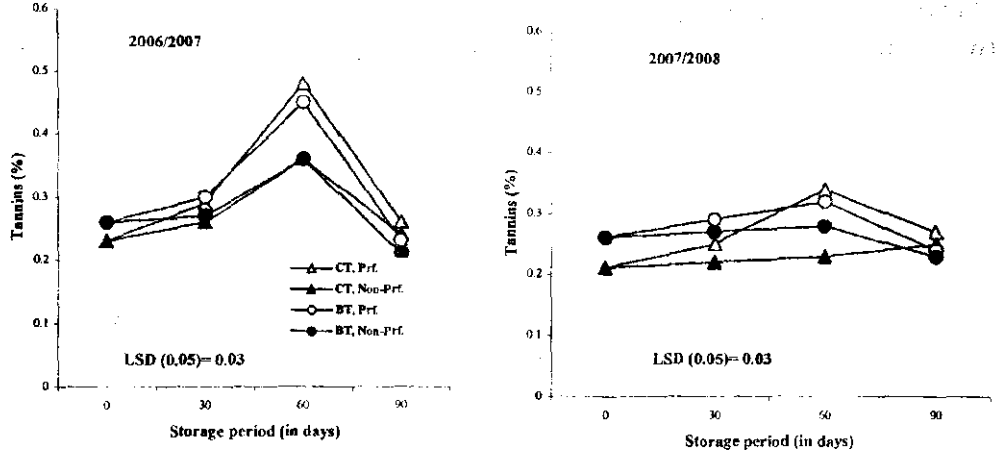

Fig . 9: Tannin changes of pomegranate fruits during cold storage of both control (CT) and best preharvest treatments (BT) as affected by type of packages (Perforated and non-perforated bags).

Total phenols

The major phenolic compounds in pomegranate fruit include punicalagin, punicalin, gallagic acid, ellagic acid and gallic acids (Kulkarni *et al.*, 2004). The decrease in total phenolic reduces the astringency of the fruit (Ozawa *et al.*, 1987), which is a desirable sensory attribute in pomegranate. Some phenolics are substrates for enzymatic browning. Incidence of internal browning of arils is one of the major problems in pomegranates, which usually occurs in over-ripe fruits (Waskar and Roy, 2000).

Fruits content of phenols was slightly reduced one month after storage compared with values recorded at harvest. They sharply increased thereafter reaching maximum after two months of storage, followed by a sharp decrease at three months of storage. Fruits of non-perforated bags contained higher phenol values than those of perforated bags especially at two months of storage. Moreover, in the second experimental season, the observed reduction of total phenols

after one month of storage was recorded only from fruits of perforated bags. Fruits of best preharvest treatment had lower values of total phenols than those of control fruits at time of harvest and especially at two months of storage (Fig. 10). The increase of phenolics in control fruits may be attributed to over ripe.

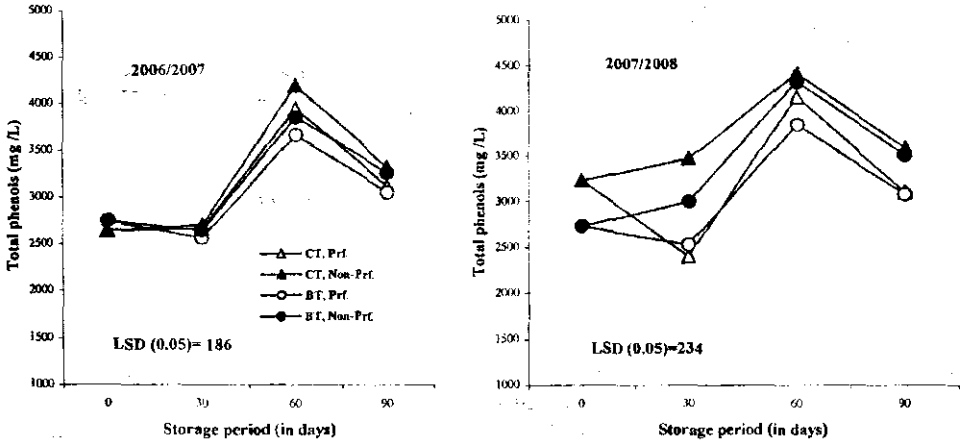

Fig . 10: Phenols changes of pomegranate fruits during cold storage of both control (CT) and best preharvest treatments (BT) as affected by type of packages (Perforated and non-perforated bags).

Total anthocyanins

Anthocyaninidins in pomegranate seed coats, in decreasing order, are cyanidin 3- glucoside, delphinidin 3-glucoside, cyanidin 3,5-diglucoside, delphinidin 3,5- diglucoside, pelargonidin 3-glucoside and pelargonidin 3,5-diglucoside (Miguel *et al.*, 2004).

Juice content of anthocyanins was slowly increased during the first month of storage, then increased sharply reaching maximum after two months of storage, followed by a sharp decreased again reaching minimum after three months of storage. After two months of storage, fruits of best treatment recorded higher anthocyanin values than those of control especially when they stored in perforated bags (Fig. 11).

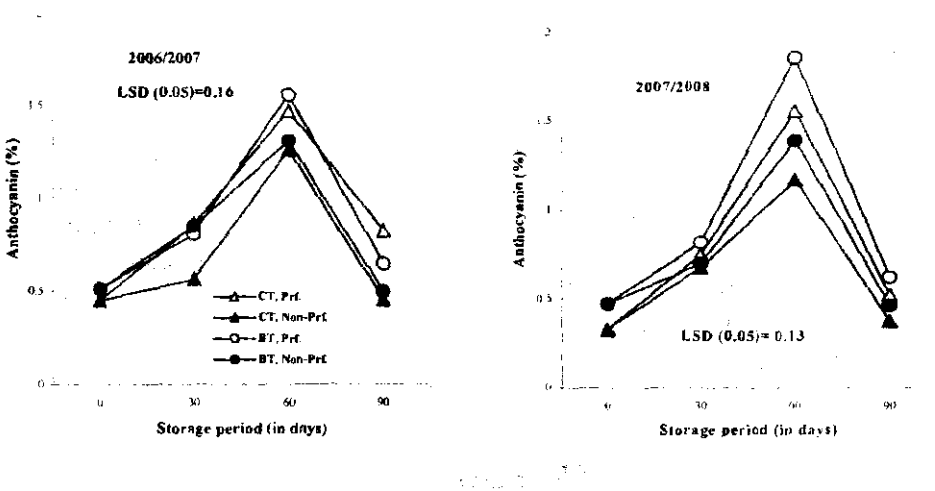

Fig. 11: Total anthocyanin changes of pomegranate fruits during cold storage of both control (CT) and best preharvest treatments (BT) as affected by type of packages (Perforated and non-perforated bags).

The increase in the total amount of anthocyanins during the first two months of storage may be due to continued biosynthesis of phenolic compounds after harvest, related to the ripening processes as reported by Miguel *et al* (2004) on 'Assaria' pomegranates. The increase of anthocyanin concentration after harvest was also reported in pomegranates (Gil *et al.*, 1995 and Holcroft *et al.*, 1998) and was correlated with the activity of the enzymes of the anthocyanin biosynthetic pathway: phenylalanine ammonia lyase (PAL) and UDP-glucose: flavonoid-3-O-glucosyltransferase (GT). Nevertheless, in the juice of pomegranates stored in different atmospheres, Holcroft *et al.*, (1998) observed that the increase in the total amount of anthocyanins was correlated with PAL activity but not with GT activity.

The decrease in the anthocyanin content after three months of storage may be attributed to a decrease in acidity. The anthocyanin pigments undergo reversible structural transformation with a change in the acidity (Cabrita *et al.*, 2000).

CONCLUSIONS

According to the obtained results, 'Manfalouty' pomegranate fruits of best preharvest treatment (Each tree/year fertilized with 500g N (1.5kg ammonium nitrate), 150g P_2O_5 (1.0kg calcium superphosphate) + 75g phosphorine (Bio-fertilizer) and 360g K_2O (0.75kg potassium sulphate) and foliar sprayed four times with a solution containing kaolin, macro and micronutrients) kept well under the refrigerating conditions up to two months with slight better advantageous than preharvest control fruits. To maintain better fruit colour and juice quality as well as avoiding decay during cold storage, it is recommended to package the fruits in micro-perforated polyethylene bags.

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REFERENCES

Artes, F., J. A. Tudela and M. I. Gill 1998. Improving the keeping quality of pomegranate fruit by intermittent warming. Z Lebensm Unters Forsch A, 207: 316-321.

Artes, F., J. A. Tudela and R. Villaescusa 2000. Thermal postharvest treatments for improving pomegranate quality and shelf life. Postharvest Biol. Technol. 18: 245-251.

Association of Official Agricultural Chemists (1985) Official Methods of Analysis (AOAC) 13Ed., pp. 494-500.

Cabrita, L., T. Fossen and O.M. Andersen 2000. Colour and stability of the six common anthocyanidin 3-glucosides in aqueous solutions. Food Chemistry 68: 101-107.

de Mann, J. M. 1999. Principles of Food Science. Aspen Publications: Maryland.

Elyatem, S.M. and Kader, A., 1984. Postharvest physiology and storage behaviour of pomegranate fruits. Scientia Hortic. 24: 287-298.

Eris, A. and R. Turk 1995. Heat treatments and different packaging materials for the modified atmosphere storage of pomegranate fruits. CihemOptions Mbditerranbennes, Sér. A /na 19 - Les fruits et légumes dans les économies méditerraneennes.

Gil M.I, C. Garcia-Viguera, F. Artes, F.A. Tomas-Barberan 1995. Changes in pomegranate juice pigmentation during ripening. J Sci Food Agric. 68: 77–81.

Gill, M. I., J. A. Martinez and F. Artes 1996. Minimally processed pomegranate seeds. Lebensm.-Wiss. U.-Technol., 29: 708-713.

Gomez, K.A. and A.A. Gomez (1984) Statistical Procedures for Agricultural Research. John Wiley and Sons- New York, USA pp. 680.

Holcroft D.M, M.I. Gil and A.A. Kader 1998. Effect of carbon dioxide on anthocyanins, phenylalanine ammonia lyase and glucosyltransferase in the arils of stored pomegranates. J. Am Soc Hortic Sci. 123 (1): 136–140.

Kader, A.A., A. Chardas and S. Elyatem 1984. Responses of pomegranate to ethylene treatment and storage temperature. Calif. Agric. 38: 14-15.

Koksal, A.I., 1989. Research on the storage of pomegranate (cv. Gok Bahce) under different conditions. Acta Hort. 258, pp. 295302.

Kulkarni, A.P., S.M. Aradhya and S. Divakar 2004. Isolation and identification of a radical scavenging antioxidant punicalagin from pith and carpellary membrane of pomegranate fruit, Food Chemistry 87: 551-557.

Melgarejo, P., D.M. Salaza and F. Artes 2000. Organic acids and sugars composition of harvested pomegranate fruits. European Food Research and Technology 211: 185-190.

Miguel, G., C. Fontes, D. Antunes,* A. Neves, and D. Martins, 2004. Anthocyanin concentration of "Assaria" pomegranate fruits during different cold storage conditions. J Biomed Biotechnol. 5: 338–342.

Nanda S., D. V. Sudhakar Rao and S. Krishnamurthy (2001). Effects of shrink film wrapping and storage temperature on the shelf life and quality of pomegranate fruits cv. Ganesh. Postharvest Biology and Technology 22 (1): 61-69.

Onur, C. 1989. An Innovation in Pomegranate Storage. (Turk. with Engl. Summary). Derim 6 (2): 88-93.

Onur, C., M. Pekmezci, H. Tibet, M. Erkan, S. Gozlekci and P. Tandogan 1992. A research on cold storage of pomegranate cv.Hicaz. 1 st National Horticultural Congress of Turkey, 13-1 6 Oct.1992, Izmir, Turkey. Aegean Univ., Agric. Fac. (l): 449-452.

Ozawa, T., T.H. Lillas and E. Haslam 1987. Polyphenol interactions: astringency and the loss of astringency in ripening fruit, Phytochemistry 26: 2937-2942.

Ranganna, S. 1978. Manual of analysis of fruit and vegetable products, Tata McGraw-Hill Publising Company Limited, New delhi.

Salunke, D.K. and Desai, B.B., 1986. Low temperature storage of pomegranate fruits. In: Postharvest Biotechnology of Fruits 2, CRC Press, Boca Raton, FL, pp. 65-67.

Spanos, G. A., and R.E. Wrolstad 1990. Influence of processing and storage on the phenolic composition of thompson seedless grape juice. J. Agric. Food Chem. 38: 1565-1571.

Singleton, V. L. and J. A. Rossi 1965. Colorimetry of total phenolics with phosphomolybdic-phosphtungstic acid reagents. Am. J. Enol. Vitic. 16: 144.

Waskar, D.P., P.B. Khedkar and V.K. Garande 1999. Effect of postharvest treatments on storage behaviour of pomegranate fruits under room temperature and cold storage. Indian. Food Packer 53: 11-15.

Waskar, D.P. and S.K. Roy 2000. Postharvest technology of pomegranate fruit a review, Indian Food Packer 54: 78-84.

Wilde S.A., R.B. Corey, J.G. and G.K. Voigt (1985). Soil and Plant Analysis for Tree Culture. Oxford & IBH Publishing Co. New Delhi.

محاولات لإتخاذ افضل معاملة لازمة للحصول على ثمار مثالية قابلة للتسويق واثرها على امد تخزين ثمار الرمان 'المنفلوطي: ٢- تاثير افضل معاملات ما قبل الحصاد على التغيرات الحادثة للثمار بعد الحصاد واثناء التخزين في العلاقة مع نوع العبوة

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تم تقييم معاملتين ما قَبْلَ الحصاد لأشجار رمان 'منفلوطى'عمرها ٧ سنوات نَامية فى تربة رملية، وهما ١-أفضل معاملة (محصول عالي مع أقلّ انْشقاق ولفحة الشمس) ٢- معاملة الكنترول على أمد تخزين الثمار بعد الحصاد. تم وضع ثمار كلتا المعاملتين في ظروف التَبريد باستعمال أكياس من البولى ايثلين المُغلقة أو المثقّبة الدقيقة (كثافة منخفضة، ٠,٠٢٥ مليمتر سمك). تم تقدير العوامل الطبيعية والكيميائية المتعلقة بالجودة (لون الثمار، فقد الوزن، التلف، نسبة المواد الصلبة الكلية ، الحموضة الكلية، حامض أسكوربيك، التانينات، الفينولات الكلية والانثوسيانينات الكلية) في وقت الحصاد ومرة واحدة كل شهر لمده ثلاثة شهور.

كنتيجة لهذه الدراسة، تعتبر الفترة المُقترحة القصوى لتخزين ثمار الرمان المنفلوطي هى شهرينْ، بينما التخزين لمده ثلاثة شهور فهي غير موصى بها وذلك لحدوث بعض التغيرات الغير مقبولة في مظهر ومكونات الثمار. الاختلافات في هذا الصدد بين كلتا معاملتين ما قَبْلَ الحصاد كَانتْ قليلة. أفضل النَتائج تم الحصول عليها عند وضع ثمار كلتا معاملتين ما قَبْلَ الحصاد فى أكياس بولى ايثلين مثقّبة.