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Effect of fruit dipping in hot water and cold storage duration on postharvest pear fruit characteristics

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***Key Words**: Pear Fruit, Hot Water, Storage Duration, Fruit Quality.*

Abstract

Fruit samples of Harme Naska cultivar were subjected to hot water at 30°C and 50°C for 2 minutes after harvest and kept at 2 ±1°C in a cold room for 30 and 60 days in order to investigate the effects of hot water dipping and cold storage durations on some quality parameters (weight loss, total soluble solids, titratable acidity, fruit firmness, carotene, pectin and vitamin C contents). The main purpose of the study is to make some improvements in the previous properties and so the eating qualities would be better.
Fruits dipped in 50°C for 2 minutes and cold stored for 60 days gave the highest water loss and carotene content while those dipped in tap water and cold stored for 30 days resulted in the greatest titratable acidity, fruit firmness and pectin content. No significant differences were observed for the effect of cold storage duration combined with hot water on total soluble solids while vitamin C content in the fruits was the most when they were dipped in various levels of hot water and cold stored for 30 days.

Introduction

There are several species of pear belonging to the genus Pyrus and Rosaceae family. Pear is considered as the third important temperate fruit after grape and apple. All pear species are originated either in central or eastern Asia [1]; Asia comes first in producing pears followed by Europe. Pears can be consumed as fresh fruit, juice, salad, canned product and dry fruit. 80% of the total pear production is for fresh consumption [2]. The total world production of Pear is estimated to be over 24.411 million tons in 2014 [3]. Pear is one of most important deciduous fruit cultivated in Iraqi Kurdistan region for the purpose of fresh fruits consumption.

Most pear fruits require cold storage before ripening; they are usually harvested at mature green stage and ripened off the tree [4] and [5]. Generally fruits need 10-100 ppm ethylene for ripening [6]. Level of ethylene biosynthesis is influenced by cold storage which also accelerates ethylene synthesis and consequently premature ripening [7].

In order to maintain the product quality, the harvested fruit is treated with some fungicides which have many negative effects on the food safety and environment. Therefore, there is a safer method need to develop an alternative to fungicides treatment. Hot water following harvest is recommended for this purpose [8]; it was also applied to peaches and nectarines in order to prevent postharvest decay [9] and [10]. Hot water may influence killing of pathogens either directly or indirectly [11]. So it can be used as an alternative to methyl bromide.

Blue and grey rots are two diseases caused by *Penicillium expansum* and *Botrytis cinerea* respectively [12] which may be controlled by hot water through its effect on changes in physiological processes such as reduction of chilling injury and killing of critical insects which contaminate the environment [13], [14] and [15].

Postharvest decay is the main problem facing storage life of several fresh harvested horticultural crops. The susceptibility increases during prolonged storage. Postharvest heat treatment was used on a commercial scale to control fungal diseases and insect infestation of horticultural crops. Consequently, the use of heat treatment was abandoned as fungicide treatments are of greater advantages due to their effects on fruit, lower cost and ease of application, Therefore, the objective of this study is to investigate the effect of hot water and storage condition duration on pear quality during cold storage and ripening stages.

MATERIAL AND METHODS

The study was carried out during 2014 on late ripe Harme Naska fruit cultivar at a private orchard in Chwarta, Sulaimani governorate. A quantity of 2 kg samples of uniform fruit were taken and placed in perforated paper bags which were then transported immediately to postgraduate laboratory in the department of Horticulture, Faculty of Agricultural sciences, University of Sulaimani.

The samples were taken at mature stage (commercial maturity) [with (11±1) kg/cm^2 flesh firmness and Total soluble solids (10±1)] on Nov. 1 2014.

Factorial experiment of two factors was used in a completely randomized design with three replicates and the treatment means were then compared according to Duncan's multiple range tests at 0.05 levels **[16].** Two factors: water temperature (tap water, hot water at 30°C and 50°C) for 2 minutes and two cold storage periods (30 and 60 days) at 2±1°C and 90-95% relative humidity were investigated for the purpose of controlled ripening.

After the storage, the fruit samples transferred to the ripening room at 20°C with 100 ppm ethylene (±20 ppm) for 3 days [17].

The following parameters were measured:

1- Weight loss (WL %):

Determined with the method described by [18] according to the formula below:

Fresh weight loss (%) = [(A-B)/A] x 100

A: initial fruit weight. B: fruit weight after storage period

2-Total soluble solids (TSS %):

Total Soluble Solid was determined by Hand Refractometer as described in [19].

3- Titratable acidity (TA %):

The same method mentioned for TSS was also used for determining TA%. The samples were titrated with NaOH using phenolphthalein index and the acidity was determined as Malic acid content (g/100 ml juice).

$$\text{Titratable acidity} = \frac{\text{Vol. NaOH ml } \mathbf{x} \text{ N. } \mathbf{x} \text{ Milli.eq. Of Acid (0.067)}}{\text{Sample volume}} \times 100$$

4- Fruit firmness (kg/cm2)

Fruit firmness was determined according to **[20]**.

5- Carotene:

Pigment content in the pear skin has been determined using the method described by [21]:

The following formula was used for determining carotene:

$$\text{Amount of total carotene (mg/l)} = \frac{\text{Optical density at 480 nm} \times \text{volume of the solution used}}{100 \times 2300} \times 1000$$

In order to change the amount to mg/100 g of the sample weight, the following formula is used:

$$\text{Amount of total carotene (mg/100 g)} = \frac{\text{amount of total carotene } (\frac{\text{mg}}{\text{l}})}{1000} \times \frac{100}{\text{weight of the sample (g)}}$$

6- Pectin Substances:

Pectin Substances were determined according to Carre and Hayne's method as described in [22].

7- Vitamin C (mg/ 100 ml):

Method used for determination was described by [23].

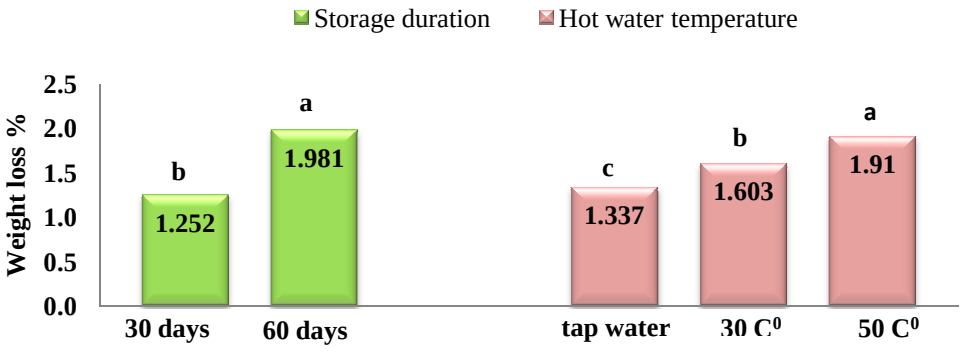
3. Results and Discussion

3.1 Effect of hot water dipping and cold storage duration on fruit weight loss%:

Figure (1) shows that 60 days cold storage duration was superior significantly to 30 days with regard to weight loss %. The figure also shows that 50 °C hot water dipping resulted significantly the highest weight loss followed by 30°C which is superior significantly to the tap water.

Table 1 indicates that fruits cold stored for 60 days and dipped in 50°C hot water gave the highest water loss which was superior significantly to all others and the lowest value was 30 days cold storage dipped in tap water.

Weight loss may be due to loss of water through transpiration, respiration and vapor pressure deficit (VPD) between fresh produce and the surrounding air [24]. The fruit weight loss increased gradually with storage duration and increase in temperature, the physical properties of the fruits were affected as well which agree with [25, 26 and 27].

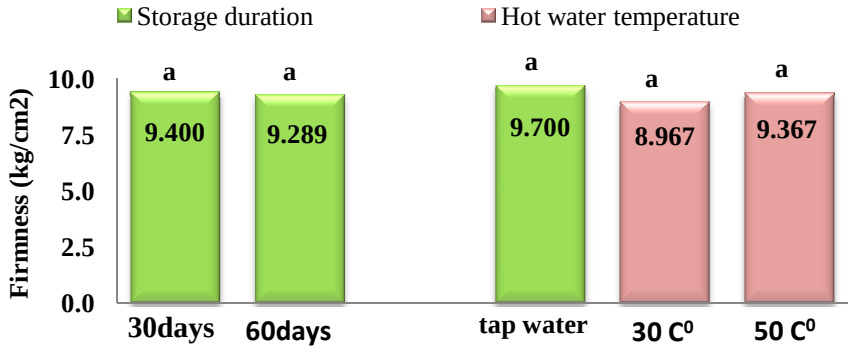


ght loss%

3.2 Effect of fruit dipping in hot water and cold storage duration on fruit Firmness (kg/cm^2):

No significant differences were found between 30 and 60 days cold storage duration in relation to firmness of fruits. The same pattern was noticed for different hot water dipping fruits (Figure 2). Fruits cold stored for 30 days and dipped in tap water recorded the highest firmness (table 1) which is not different significantly from the other two way interactions except combination of 60 days cold storage and 30°C hot water.

Fruit firmness changes may be due to some factors such as surrounding environment before harvesting, physiology and age of the trees and maturity degree of fruits [27]. fruits dipped in hot water lead to the disturbance of cell structure and membrane damage which can be the source of decreasing in fruit firmness, the decline in fruit firmness may be due to the gradually breakdown of proto-pectin to lower molecular fractions which are more soluble in water and this was directly correlated with the rate of softening of the fruits [28]. Fruit structure disturbance will occur under long cold storage period [29]. 'Eldorado' pear fruit found to maintain its firmness though it has stored for a long period [30].

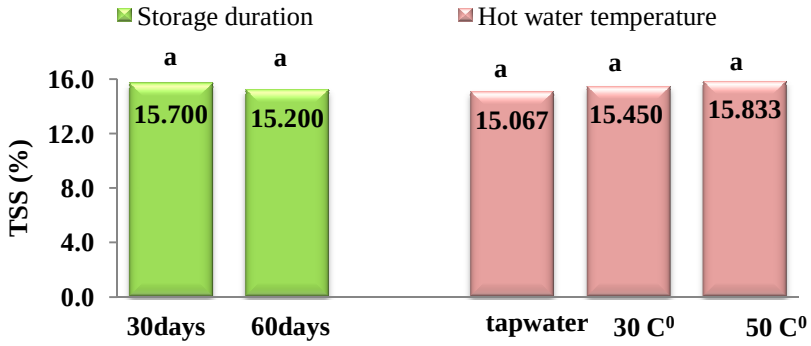


mness (kg/cm2)

on weight loss % and

nness (kg/cm^2)
10.067 a
9.167 ab
8.967 ab
9.333 ab
8.767 b
9.767 ab

3.3 Effect of fruit dipping in hot water and cold storage duration on Total soluble solids (TSS %):
Figure (3) shows no significant impact of storage duration on TSS %, also no significant differences were observed for hot water on TSS %. No significant differences were also noticed for the combination of cold storage duration with hot water (Table 2). Our results are in congruent with those found by [31] and [32].

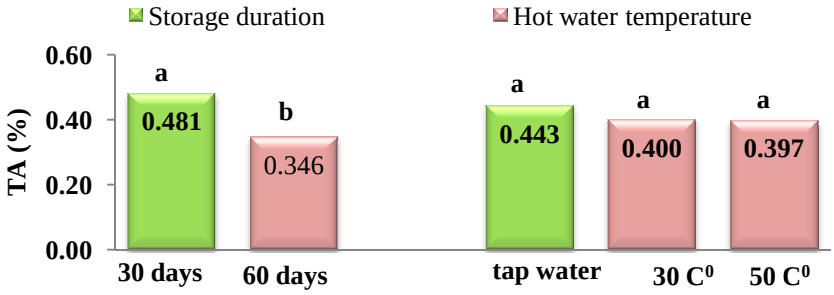


al soluble solids (TSS %)

A (%), Carotene (mg/100g),

(%)	Vitamin C (mg 100^{-1} ml)
a	*3.873 a*
ab	*3.825 a*
bc	*3.729 a*
cd	*2.831 b*
de	*2.260 bc*
e	*1.833 c*

3.4 Effect of fruit dipping in hot water and cold storage duration on fruit titratable acidity (%):
Titratable acid (TA) found as malic acid in fruits. Figure 4 indicates that storage duration for 30 days exceeds significantly that of 60 days with regard to fruit titratable acid, whereas, no significant differences were found among hot water temperatures on fruit titratable acid.
Table 2 exhibits that fruits stored for 30 days and dipped in tap water result in highest TA% which is superior significantly to all other interactions. The lowest value (0.30% TA) was recorded for fruits stored for 60 days and treated with tap water.
Percentage of titratable acid decrease in pear as a result of hot water treatment resembles other fruits such as apple, grape and tomato**;** Long storage period causes the decrease in titratable acid in fruits. Descending in titratable acid caused by temperature increase causes the increase in respiration process [11].
This result is agreement with previous studies [34] and [33].



:able acid

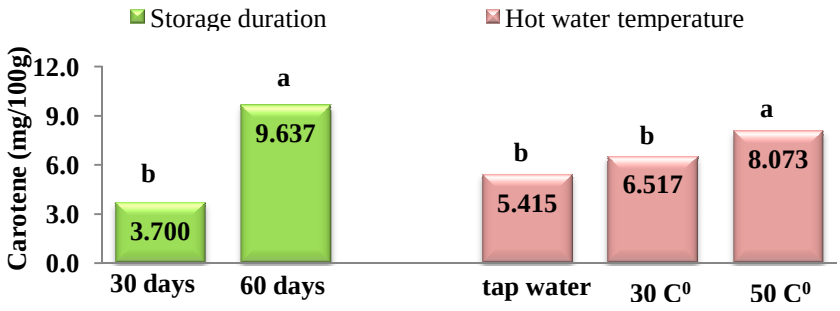
3.5 Effect of fruit dipping in hot water and cold storage duration on Carotene (mg/100g):

The fruit color plays a key role in the marketing value and quality index. Data in the (Figure 5) Exhibits that carotene content in fruits cold stored for 60 days surpassed significantly those stored for 30 days. The same figure shows the gradual increase of carotene content when temperature of water increased from the tap water to 50°C and the last one was superior significantly to both tap water and 30°C hot water .

Table 2 indicates that carotene content in fruits dipped in 50°C hot water and cold stored for 60 days exceeded significantly the other combinations of cold storage duration and hot water combinations while the least value was recorded for the combination of tap water and cold stored for 30 days.

This decrement in carotene could be attributed to it's gradually destruction by polyphenol oxidase [35]. The results agree with those found by [36] who found that Immersion of bell peppers in hot water at 50 ºC for 3 min or 55 ºC for 1 min, followed by packaging, resulted significantly in reducing carotenoids content compared with fruits treated with hot water alone or not treated with water. However, hot water treatment combined with polypropylene bags (PPB) was the most effective treatment in reducing carotenoids loss during storage.

These results are in agreement with those obtained by [37] who indicated that all the treated treatments raised the amount of β-carotene content over the untreated ones. This might be due to the fact that hot water treatment favored translocation of carotenoids from the peel to the pulp and resulted in higher β-carotene content in the treated bananas. The results are also in agreement with those obtained by [38] who found that hot water treatment followed by packaging with polyethylene film was effective in inhibiting color development of sweet pepper fruits during storage at 8 ºC.



Carotene (mg/100g)

3.6 Effect of fruit dipping in hot water and cold storage duration on Pectin%:

Data in the **Figure 6** indicates that the pectin content of fruits stored for 30 days was superior significantly to those stored for 60 days. Also the figure exhibits that tap water dipping was superior significantly to 50°C hot water with regard to pectin content.

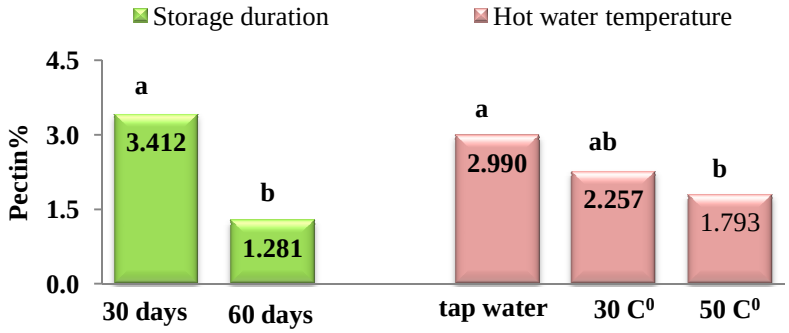
In contrast to carotene content, table 2 explains that pectin in fruits dipped in tap water and cold stored for 30 days were superior significantly to all other cold storage duration and hot water combinations except

combination of 30°C hot water and 30 days cold storage and least value was recorded for 50°C hot water fruits cold stored for 60 days.

Polygalacturonase (PG) is responsible for pectin breakdown in fruits. Pectin, a cell wall polysaccharide, is responsible for fruit texture. A change in texture is an essential part of ripening in most fruits. In peach, PG activity was associated with an increase in water soluble pectin and fruit softening [39]. [40] Pectin is classified into two forms exo-PG in freestone and clingstone fruits and showed that the activity of each of the two forms was higher in ripe (soft) than in immature or mature firm fruit. Post-harvest heating of fruits resulted in lowering the activities of cell wall degrading enzymes.

[39] Reported that solubilization of pectin is a fundamental and important aspect of fruit ripening. [41] Also reported that heat allows demethylation of pectin by pectin methyl esterase to form anionic COO– groups with which Ca^{+2} ions can form salt bridge cross links. This may make the cell wall less accessible to the enzymes that cause softening. Therefore, the combination of both postharvest dips and heat treatment may control ripening; softening and decay at the same time [42]. Higher duration of heat treatment or higher temperatures resulted in lesser decline of pectin during storage due to inactivation of pectin degrading enzymes.

These results are in agreement with those obtained by [43] who found that the pectin contents decreased during storage in heat treatments.

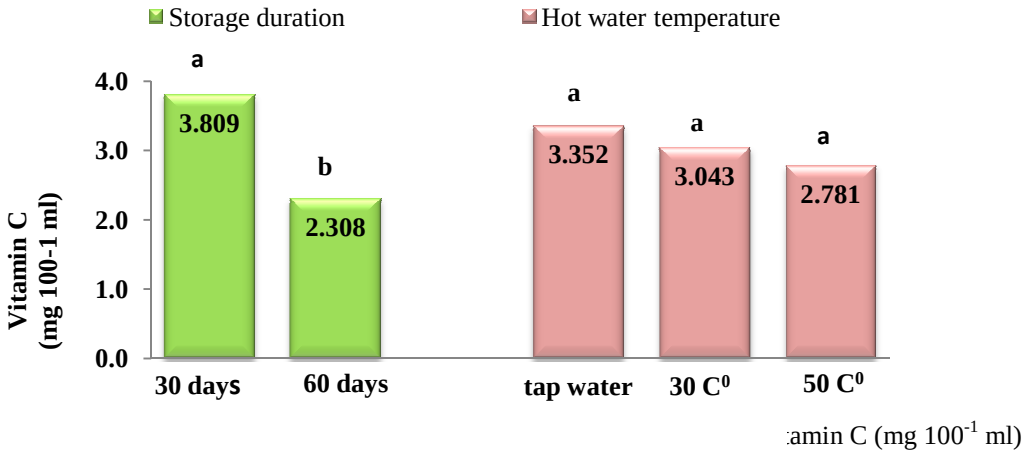


n Pectin%

3.7 Effect of fruit dipping in hot water and cold storage duration on Vitamin C (mg 100^{-1} ml):

Figure 7 shows that vitamin C in fruits stored for 30 days exceeded significantly those stored for 60 days, whereas, no significant differences were found among fruits dipped in various levels of hot water but the highest values of vitamin C was recorded for fruits dipped in tap water.

Table 2 displays that vitamin C content of fruits dipped in various levels of hot water and cold stored for 30 days was superior significantly to those dipped with the same levels of hot water but cold stored for 60 days. The loss in vitamin C content with the progress of storage period could be attributed to rapid conversion of L-ascorbic acid into dehydroascorbic acid in the presence of L-ascorbic acid oxidase [44], also the reduction in vitamin C contents during ripening might be attributed to the oxidation of ascorbic acid as ripening proceeded [45]. The results agree with those found by [46] who found that control mango fruits and hot water treatment showed significantly lowest values of vitamin C. This finding agrees with other authors [36] who found that ascorbic acid content significantly decreased with prolongation of storage period. This reduction might be due to the higher rate of sugar loss through respiration. The results are also similar to those obtained by [47], [48] and [49].



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