Indian Journal of Fundamental and Applied Life Sciences ISSN: 2231-6345 (Online)
An Open Access, Online International Journal Available at http://www.cibtech.org/jls.htm
2014 Vol. 4 (3) July-September, pp.495-500/Akbari and Ebrahimpour
Research Article

INTERACTION BETWEEN POTASSIUM PERMANGANATE AND HEAT TREATMENT ON QUALITY AND STORABILITY OF ISFAHAN QUINCE FRUIT (*CYDONIA OBLONGA* MILL.)

***Hassan Akbari[1] and Hassan Ebrahimpour[2]**
[1]Department of Agriculture and Natural Resource, Research Centre of Isfahan, Isfahan, Iran
[2]Department of Agriculture, Shirvan Branch, Islamic Azad University, Shirvan, Iran
**Author for Correspondence*

ABSTRACT
Although the skin of quince has a thick coat of fuzz, the fruit is tender and bruises easily. Quince fruits are sensitive to postharvest disorders and pathology caused by storage conditions and time period. Inappropriate conditions of storage results in fruit loss. Effect of potassium permanganate and heat treatments on fruit quality and storability was investigated in order to enhancing storability period and decreasing fruit losses. Fruits treated with two levels of potassium permanganate (2 and 4 g per kg of weight fruit) at 38°C for 36 and 72 hr and packed in polyethylene bags. Bags stored in a 0°C and 85-90% relative humidity, for 75 and 150 days. Results showed that the lowest decrease in flesh firmness, skin color change and astringent taste belonged to applying 4 g/kg of potassium permanganate and 36 hr of heat treatment. There was significant difference between applying 2 and 4 g/kg potassium permanganate in respect of *B*-carotene content, total soluble solids and astringent taste after 75 and 150 days of storage. After 150 days there was significant difference between 4g/kg potassium permanganate and 36 hr of heat treatment and 2g/kg potassium permanganate for 72 hours in respect of astringent taste and *B*-carotene content.

Keywords: *B-carotene, Flesh Firmness, Storability, Quince, Isfahan*

INTRODUCTION
Quince (*Cydonia Oblonga* Mill.) belongs to Rosaceae family. Isfahan variety of quince is cultivated in most of Iran regions due to its high quality of fruit (such as large size, sweet taste, high transportability and fruit shape) (Maniee, 1994). There is a positive correlation between proper fruit harvest process and time, packing, transport and storage condition with storability and fruit quality. Qualitative and quantitative characteristics of fruit are important on its marketability (Chaves *et al.*, 2007). The most proper time of harvesting Isfahan variety for storage is 181days after full bloom (Ghasemi and Moshref, 2003). Heat treated is a no chemical technique for saving fruit qualitative characteristics during storage. Heat treated results in lower activity of exo-poly-galacturonase which causes flesh firmness maintenance, fruit resistance to pathogens and physiological disorders, regulating postharvest process and lower weight loss. Postharvest heat treatments lead to an alteration of gene expression and fruit ripening can sometimes be either delayed or disrupted. The extent of the alternation of fruit ripening is a function of the exposure temperature and duration and how quickly the commodity is cooled following the heat treatment. The most commonly measured components of fruit ripening affected by heat treatments include fruit softening, membrane and flavor changes, respiration rate, ethylene production, and volatile production. Cell wall degrading enzymes and ethylene production are frequently the most disrupted and are sometimes not produced or their appearance is delayed following heating. Akbari and Rahemi (2004) reported that 36 and 72 hours Heat treated resulted in lower peel yellow color, lower acidity, *B*-carotene content, decay percent and higher flesh firmness. Flesh firmness decrease, prohibited by 36 hours of Heat treated. In other study, 48 and 72 hours of 36°C heat treatment, results in lower flesh firmness loss in apple fruits, after 75 and 150 days of storage (Saiary and Rahemi, 2002). Potassium permanganate is an ethylene oxidized which enhances storability of fruits and preserves fruit qualitative characteristics. Easy appliance and low price are the benefits of using potassium permanganate (Klein and lurie 1992). Sakaldas (2008) reported that after 6 month of storage, polystyrene packs with a cellophane wrapping

result in highest fruit quality and least browning percentage. Applying 2 and 4 g potassium permanganate in per 1 kg of fruit, and fruit bags with no holes results in lower weight loss and decay percent and higher flesh firmness compared with control treatment in bags with air hole (Akbari, 2005). Other reports stated that applying potassium permanganate without other treatments results in higher flesh firmness (Saiary and Rahemi, 2002). Applying ethylene absorbance substances prohibited weight loss, titratable acidity (TA) and total soluble solids (TSS) decrease, decay and pH enhancement and resulted in higher storability of Shahroody variety of apricot (Emadpour, 2008; Zomorodi, 2005) affirmed that potassium permanganate prohibited weight loss, flesh firmness decrease and decay in apple fruits during storage. (Heydari *et al.*, 2011) showed that, fruits treated with 10 g/kg potassium permanganate had the highest acidity and phenol content in flesh and lower soluble solids after 7 days. Interaction between potassium permanganate and salicylic acid resulted in higher flesh firmness, titratable acidity, chlorophyll content, ascorbic acid and storability of kiwifruit (BAL and Celik, 2010). (Santosa and Kholidi, 2010) reported that applying 30 g of zeolite which contains potassium permanganate resulted in lower skin color changes and higher flesh firmness in Sholihati variety of banana packed in polyethylene bag at 13°C for 18 days. Applying potassium permanganate delayed apple fruit maturity and increased TSS, fruit juice pH and decrease TA during storage (Chaves *et al.*, 2007). This study was conducted to investigate the interactions between Heat treatment and potassium permanganate on storability of quince fruits Isfahan. Effect of heat treatment and potassium permanganate investigated in two separate experiments previously, by present researcher. The aim of study was to determining the best treatment for higher quality fruits and decrease fruit loss during storage.

MATERIALS AND METHODS

A factorial experiment base on complete randomized design with four replications was carried out. Studied factors were two levels of Heat treatment at 38° C (36 and 72 hr), two levels of applied KMnO4 (2 and 4 g per kg weight fruit) and four levels of storage periods (75, 150 days and plus 7 days storage at 20°C after 75,150 days). Fruit Heat treated applied in 38°C oven. KMnO4 applied in sachets with gas exchange capacity and placed beside fruits in polyethylene bag with 70 µ thickness. 10 fruits studied in each treatment. Flesh firmness, total soluble solids (TSS), and peel color, *B*-carotene content and astringent taste measured after applying treatments. Then fruits stored at 0°C and 85-90% relative humidity for 75 and 150 days. After storage fruit characteristics measured twice: immediately after moving from cold storage and seven days after moving from cold storage and remaining at 20°C. Fruit firmness measured applying a penetrometer (F-T, F.T. 327) with 7 mm probe diameter. TSS measured with a digital refractometer (Bleeker- model 52436). Result expressed as Brix degree. Beta carotene measured applying using high performance liquid chromatography. Five grams of fruit sample mixed and added to 40 ml acetone, 60 ml hexane and 0.1 g magnesium carbonate solution and mixed again for five minutes. The mixture filtrated and rinsed with 25 ml acetone and 25 ml hexane. Acetone isolated by separator funnel and rinsed with distilled water. Sodium sulfate, acetone and hexane added the solution and concentrated by nitrogen gas. Several drops of solution added to HPLC column. Outlet solvent wave length, which contains beta carotene, measured applying spectrophotometer. Spectrophotometery applied at 440 nm, to determine beta carotene content (Hosseini, 1990). Astringent taste determined according to folin-denis method in 100g of fruit flesh (Hadadchi, 1986). Peel color determined by color card. Samples scored 1 to five while 1 belonged to light green and 5 belonged to deep green color of peel. Average of color change of fruit peel determined during time. Data analyzed statistically and multiple range tests carried out for comparing means.

RESULTS AND DISCUSSION

Interaction between potassium permanganate and heat treatment was significant on fruit peel color during different storage periods (figure 1). The lowest color change from green to yellow belonged to applying 4 g of $KMnO_4$ and 36 hours of heat treated after 75 days of storage. There were significant differences

between treatment 4 g of potassium permanganate and 72 hr of heat treated in respect of color change after 75 and 150 days of storage.

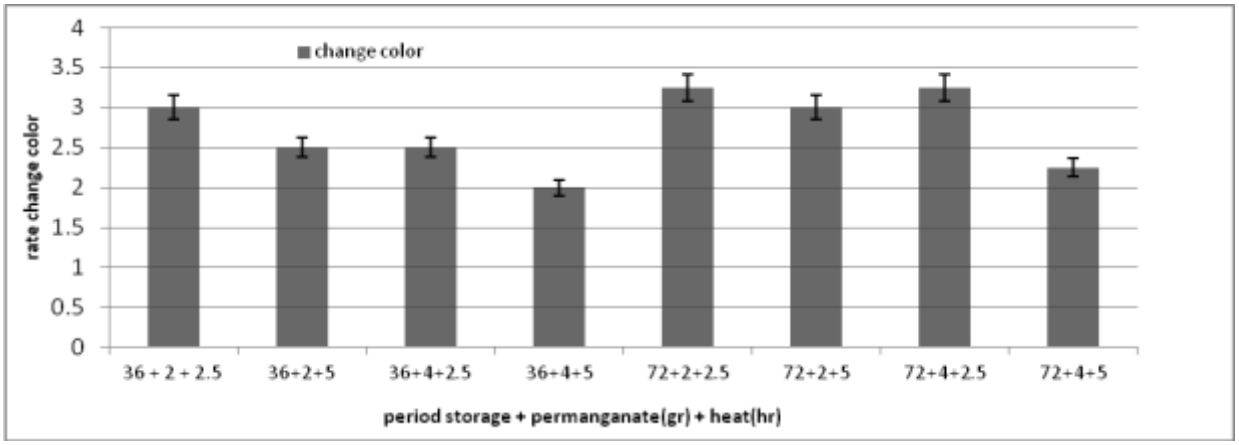

Figure 1: Interaction between potassium permanganate and heat treatment of change color after 75 and 150 days of storage

There was significant difference between peel color of 36 and 72 hr of heat treatments immediately after storage and after 7 days of remaining at 20 °C (figure 2). The lowest color change belonged to applying 4 g of $KMnO_4$ in both heat treatments levels. Thus it seems that peel color change more affected by KMnO4 rather than heat treatment. Climacteric fruits produce ethylene during maturity which results in protein synthesis and activating of chlorophyllase enzyme. Activity of chlorophyllase results in chlorophyll analysis and peel color changes from green to yellow. $KMnO_4$ absorbed ethylene and resulted in lower activity of chlorophyllase and consequence color yellowing. Ethylene activity decreased by CO_2 aggregation in bags with no air hole which results in lower chlorophyllase enzyme action and chlorophyll degradation. Results were in agreement with Reramales and Campos (1997) which reported that potassium permanganate treated fruits of pear have more green peel color after 75 days of storage compared with not treated fruits. There was significant difference between different potassium permanganate and heat treatment levels in respect of flesh firmness (table 1). The highest flesh firmness (10.95 g/cm^2) belonged to applying 4 g of potassium permanganate and 36 hr of heat treatment. The lowest flesh firmness (8.3 kg/cm^2) belonged to applying 2 g of $KMnO_4$ and 72 hr of heat treatment.

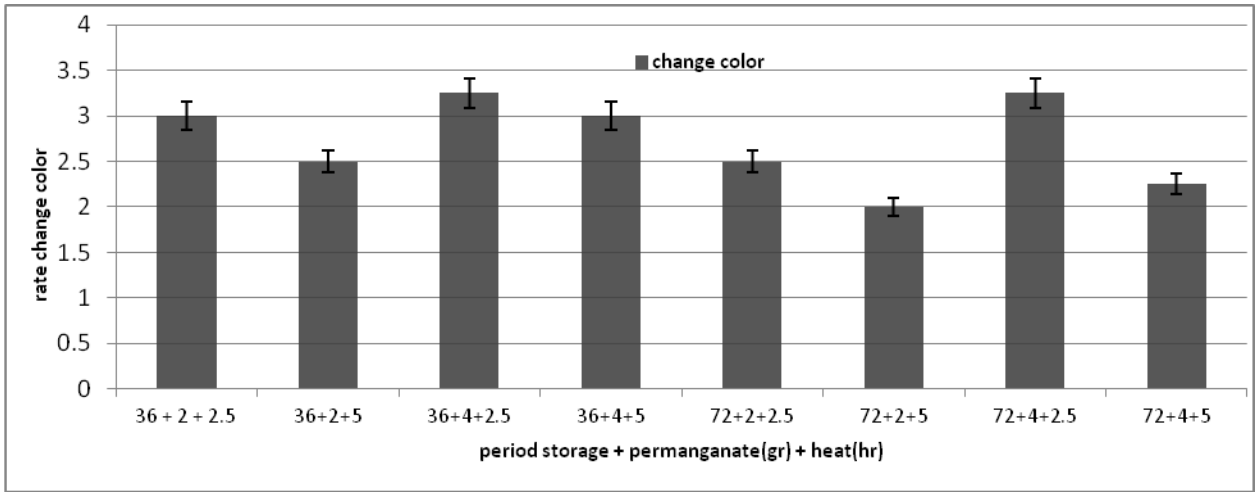

Figure 2: Interaction between potassium permanganate and heat treatment of change color after 75 and 150 days storage and plus 7 days remained at 20°C

There was significant difference between flesh firmness of samples immediately after storage and after 7 days remaining at 20°C ($p<0.05$) (table 2). The highest flesh firmness (10.75 kg/cm^2) belonged to 4 g potassium permanganate and 36 hr of heat treatment. The lowest flesh firmness (8.2 kg/cm^2) belonged to 2 g $KMnO_4$ and 72 hr of heat treatment. There was a decreasing trend in flesh firmness during storage period. The slope of trend was less by applying 4g of $KMnO_4$ compared with 2g of $KMnO_4$, after remaining for seven days at 20°C. Polygalacturonase and cellulase are important factors in fruit maturity and flesh softening by degrading cell wall pectin and cellulose compounds. These two enzymes activated by ethylene. KMnO4 reduced flesh softening by absorbing ethylene and prohibiting its activity. Methyl-esterase activated by heat treatment. This enzyme improved calcium pectate activity due to remobilization of calcium which results in higher flesh firmness (Lidster *et al.*, 1995). Results were in agreement with Rahemi and Saiary (2002), (Heydari *et al.*, 2011), (Santosa *et al.*, 2010) and BAL and Celik (2010) which reported that the higher amount of potassium permanganate result in higher absorbance of ethylene and reduce its destructive effects on cell walls by reducing Polygalacturonase and cellulase activity. Interaction between KMnO4 levels and heat treatment was significant on *B*- carotene content after 75 and 150 days (table 1 and 2). The highest *B*-carotene content (29.77 µg/mg) belonged to applying 2 g of potassium permanganate and 72 hr of heat treatment after 150 days of storage. The lowest *B*-carotene content (14.63 µg/mg) belonged to applying 4 g of $KMnO_4$ and 36 hr of heat treatment. There was an increasing trend in *B*-carotene content of fruits which treated by 2 g of $KMnO_4$ and 72 hr of heat treatment in both storage treatments (stored for 150 days and 150 days plus 7 days remained at 20°C). Enhancing in potassium permanganate prohibited *B*-carotene increase in fruits which stored for 75days. *B*-carotene content was higher in 72 hr of heat treatment compared with 36 hr. Results showed that there is a correlation between fruit maturity stage, peel color and *B*-carotene content.

Table 1: Interaction between potassium permanganate and heat treatment on fruit characteristics after 75 and 150 days of storage

$KMnO_4$ g/kg	**Heat treatment hr**	**Storage period Days**	**Flesh firmness kg/cm^2**	***B*-carotene micro g/mg**	**astringent g/100g**	**TSS %**
2	36	75	10.35ab*	18.38c	3.82b	11.25ab
		150	8.72bc	23.2b	1.43d	11.75ab
	72	75	10.18bb	19.53c	3.66b	12.5a
		150	8.30c	28.49a	1.33d	12ab
4	36	75	10.95a	14.63d	4.54a	11b
		150	9.5bc	22.92b	1.91c	10.75ab
	72	75	10.7ab	17.23c	3.83b	11.75ab
		150	8.72bc	28.27a*	1.5d	12.25a

In each column means with same letters are not significantly different ($p<0.05$)

Maturity results in chlorophyll degradation and synthesis of carotenoids and xanthophylls which results in higher *B*-carotene content in fruits. Potassium permanganate absorbs ethylene which produced by fruits. High amount of CO_2 and low O_2 concentration in bags results in low ethylene content, thus *B*-carotene and fruit maturity faced to a delay. Results were in agreement with Klein and Lurie (1992) which stated that peel color change and *B*-carotene synthesis affected by pre storage heat.

Table 2: Interaction between potassium permanganate and heat treatment on fruit characteristics after 150 days of storage plus 7 days remained at 20°C

$KMnO_4$ g/kg	Heat treatment hr	Storage period Days	Flesh firmness kg/cm^2	*B*- carotene micro g/mg	astringent g/100g	TSS %
2	36	75	9.27b*	18.65c	3.67a	11.25d
		150	8.47bc	24.88b	1.1de	13.25a
	72	75	8.8bc	20.88c	1.98c	12.5abc
		150	8.2c	29.77a	.99e	12.13bcd
4	36	75	10.75a	16.27d	3.95a	11.38d
		150	8.67bc	23.85b	1.36d	11.5cd
	72	75	8.92b	20.38c	2.75b	11.5cd
		150	8.42bc	29.45a	1.21d	12.63b

In each column means with same letters are not significantly different ($p<0.05$)

Astringent taste significantly affected by interaction between $KMnO_4$ and heat treatments after 75 and 150 days of storage, plus 7 days of 20 °C (tables 1 and 2). The lowest astringent taste (0.99 g/100g) belonged to applying 2 g of $KMnO_4$ and 72 hr of heat treatment after 150 days of storage plus 7 days of 20 °C. The highest astringent taste (4.54 g/100g) belonged to applying 4 g of $KMnO_4$ and 36 hr of heat treatment. There were significant differences between $KMnO_4$ and heat treatments in respect of astringent taste (tables 1 and 2). polyphenol oxidase activity enhances by ethylene which results in astringent taste diminish (Saiary and Rahemi, 2003). There was a positive correlation between astringent taste with high amount of KMnO4 and low heat treatment duration. Decrease in phenol components and astringent taste prohibited by delayed maturity in fruits. Astringent taste of fruits preserved using $KMnO_4$ due to its prohibiting effect of phenol degradation. $KMnO_4$ prohibited polyphenol axidase activaty by absorbing ethylene. The results are in agreement with Heydari *et al.,* (2011) which reported that phenolic compound changes in mango flesh and peel affected by $KMnO_4$. TSS did not significantly affected by interaction between KMnO4 and heat treatment after 75 and 150 days (table 1). The interaction between applying 2 g of potassium permanganate and heat treatment was significant in respect of TSS (table 2). TSS content varies between 11 to 13.25%. The highest TSS belonged to applying 2 g of potassium permanganate and 36 hr of heat treatment after 150 days of storage. Starch modifies to sugars like glucose phosphate by the activity of sucrose phosphate synthetase which enhances TSS during maturity. This enzyme activates by ethylene (Saiary and Rahemi, 2002). The absorption of ethylene by $KMnO_4$ results in the prohibition of enzyme activity. Thus starch dose not modifies to sugar and TSS content remains in low amount (Sakaldas, 2008). The lower amount of TSS in response of potassium permanganate reported in apricot (Ishaq *et al.,* 2009) and mango (Heydari *et al.,* 2011).

REFERENCES

Akbari H and Rahemi M (2004). Effect of potassium permanganate on quince fruit storability. MSC thesis, Shiraz University, Iran 95.

Bal E and Celik S (2010). The effects of postharvest treatments of salicylic acid and potassium permanganate on the storage of kiwifruit. *Bulgarian Journal of Agricultural Science* **16** 576-584.

Chaves MA, Bonomo RCF and Silva AL (2007). Use of potassium permanganate in the Sugar Apple postharvest preservation. *Cienciay Tecnologia Alimentaria* **5** 346-351.

Emadpour M, Rezaee Y and Azad A (2008). Effect nano particles of potassium permanganate granulated zeolits on Shahroodi variety of apricot. *Pajoohesh and Sazanedgi* **21** 82-89.

Ghasemi A and Moshref L (2006). Effect of harvest time on storability of Isfahan variety of quince fruit, Agricultural research center-Isfahan **683**(80) 39.

Hadadchi GH (1986). *Biochemistry and Plant Physiology* (Jahade-E-Daneshgai Publication of Mazandaran) 254.

Heydari M, Mirza-Alian A and Moradi N (2011). Investigating the effects of potssium permanganate on mango quality and storability. *Horticultural Science* **25**(2) 130-136.
Hosseini Z (1990). *Food Analysis Techniques* (Shiraz university publications) 210.
Ishaq S, Rathore HA and Sartaj A (2009). Influence of postharvest calcium chloride application, Ethylene absorbent and modified atmosphere and quality characteristics and shelf life of Apricot (*Prunus armeniaca*) fruit during storage. *Pakistan Journal of Nutrition* **8** 861-865.
Klein JD and lurie S (1992). Pre storage heating of apple fruit for enhanced postharvest quality interaction of time and temperature. *Horticultural Science* **27**(4) 326-328.
Lidster PO (1995). Laboratory evaluation of potassium permanganate for ethylene removal from CA apple storage. American Seriated. Engineering **28**(1) 321-334.
Maniee A (1994). *Quince and Pear Growing Methods* (Iran technical press) 113.
Moore JP (2003). Carotenoid synthesis and retention in mango (*Mangifera indica*) fruit and puree as influenced by postharvest and processing treatment, PhD Thesis, University of Florida, U.S.A 96.
Reramales J and Campos R (1997). Ethylene control and ripening in Packhamis and Beurre Bocs pears, *CAB Abstracts*.
Saiary M and Rahemi M (2002). Effect of warming, $CaCl_2$ and potassium permanganate on storability of Golden delicious variety of apple, MSc thesis, Shiraz University, agricultural faculty.
Sakaldas M (2008). The effects of different harvest times and packaging types on fruit quality of *Cydonia oblonga* cv. *ESME Journal of Agriculture*, faculty of H.R.U. **12**(3) 33 – 39.
Santosa WD and Kholidi F (2010). The Use of Clay as Potassium Permanganate Carrier to Delay the Ripening of Raja Bulu Banana. *Journal of Horticultural Sciences*, Indonesia **1**(2) 89-96.
Wangdup RK, Sangitasen P and Jha SK (2011). Response of different maturity stages of Sapota *Manilkara achras* cv. Kallipatti to in-package ethylene absorbent. *Journal of Food Science and Technology* **48** 763-768.
Zomorodi SH (2005). Effect of packing and potassium permanganate on fruit quality and storability of three apple varieties. *Agricultural Research* **24** 143-153.