Biological Forum – An International Journal **9**(2): 122-125(2017)

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Evaluation of Ascorbic Acid and Thyme Treatments on Physicochemical Changes in Quince Fruit

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(Received 03 August, 2017, Accepted 12 September, 2017)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: In the present investigation, effect of different levels of ascorbic acid and thyme on storage characteristics of quince fruit cultivar of Isfahan has been studied. A factorial experiment based on a completely randomized design in three replicates and each replicate with five fruits was performed. Fruits were harvested at commercial ripening stage and were sprayed with different concentrations of ascorbic acid (0, 1, 2.5 and 5 ppm) and thyme (0, 25, 50, 100 vol %). Fruits after drying in the open air were covered with wrappings paper, then were placed in cardboard cartons, and were stored for a month between 0°C to 5°C with relative humidity of 80% to 85%. After storage, weight loss fruit percentage, decay percentage, acidity amount and total soluble solids were measured. The results showed that application of ascorbic acid in compare to thyme improved chemical quality of fruits in all measured parameters, and have not showed any adversely effect on appearance and marketability of the fruit. With increasing concentrations of ascorbic acid at 5 ppm, characteristics such as firmness, taste, favorable color and total soluble solid increased. The results showed that spraying the fruit via ascorbic acid improves chemical quality of the product in all measured indices compared to thyme, it has no adverse effect on fruit apparent properties and marketing and features such as consistence, flavor, color and dissolved solids percent were increased by the increasing concentration of ascorbic acid up to 5 ppm.

Keywords: Fruit changes, Fruit characteristics, Fruit Quality, Medicinal Plant, Storage.

INTRODUCTION

Quince (*Cydonia oblonga* Mill.) fruit has a dry flesh and fluffy skin with sour and astringent taste. The fruit has variable dimensions, asymmetric shape and certain adore (Silva *et al.,* 2004). Although such fruit is eaten freshly less, due to its special characteristics, but is used extensively in food industries as different products such as jam, marmalade, jelly, dried fruit and is used to extract essence and pectin. The fruit belongs to Rosaceae family. The appearance is similar to yellow apple or pear (Westwood, 1993). Quince has a high amount of pectin and it has special flavor and adore. Between apple-shaped and pear-shaped cultivars, pear-shaped cultivar is more suitable for industrial applications. Initial ripening index of quince is change of color from green to yellow and complete ripening index is that all skin of the fruit becomes yellow. Fruit quality depends on many factors such as cultivar, weather condition during growth, ripening during harvest and storage condition (Varela *et al.,* 2007). Concerning expansion of organic cultivation and production especially in advanced countries, application of non-chemical and natural materials in all stages of horticultural products is being increased to reduce wastes and to keep bioactive compounds of the fruit (Baldwin, 2006). Thyme (*Zataria multiflora* Boiss.) is an aromatic plant from Lamiaceae family with antimicrobial effects (Sajed *et al.,* 2013). Among essences, researchers and food producers have been interested in essence of thyme because it is an antimicrobial and anti-oxidant agent. Anti-microbial and anti-oxidant effects of thyme essence have been studied in several nutrients such as sea foods, pork meat, cooked beef meat, chicken and vegetables (Kostaki *et al.,* 2009). Ascorbic acid is water soluble antioxidant and it plays important role in detoxification of active species of oxygen especially hydrogen peroxide. Ascorbic acid plays role directly in neutralization of superoxide radicals or single oxygen and plays role as a secondary antioxidant in production of alpha-tocopherol and other fat-friendly antioxidants (Noctor and Foyer, 1998).

In addition, it engages in other things such as plant growth, regulation of gene expression, regulation, activity and protection of some enzymes and redox regulation of antioxidant components attached to the membrane (Sofo *et al*., 2005; Kuzniak, 2004). Immersion treatment of quince in the compound containing ascorbic acid increased fruit life time and quality compared to control treatment (Yardugül, 2005). There is no information about Isfahan cultivar of quince. Therefore, results of the research can meet requirement of food industrialists for using such valuable fruit in production of nutrient products.

MATERIALS AND METHODS

Quince's cultivar of Isfahan was harvested in complete ripening stage (goldish yellow color of fruit skin and strong aromatic smell) in September during early hours of the day. Fruits were sprayed by ascorbic acid (0, 1, 2.5 and 5 ppm) and thyme (0, 25, 50, 100 vol %) treatments. Fruits after drying in the open air were covered with wrappings paper, then were placed in cardboard cartons, and were stored for a month between 0°C to 5°C with relative humidity of 80% to 85%. Weight reduction percent was measured and recorded using scale and calculating (Saini *et al.,* 2006). Decay percent was measured and reported by counting the number of decayed fruits in each treatment and calculating the ratio of rotted to intact fruits (Saini *et al.,* 2006). 0.1 Molar soda titration was used to measure acidity that shows amount of acid available in the fruit. To this end, 10 ml filtered extract of phenolphthalein was added and it was titrated by detecting terminal point via soda. Amount of consumed soda was calculated in terms of malic acid factor and it was reported as acidity number (Saini *et al.,* 2006). Refractometry has been used to determine brix or dissolved solids. First, refractometer was calibrated by distilled water. Then one drop of fruit extract was poured on glass prism and brix or dissolved solids' number was read opposite the light that shows amount of sugar produced inside the fruit (Shokrollahfam *et al.,* 2012). Sensing assessment was done after 30 days regarding apparent shape, color (browning amount), taste and flavor based of hedonic ranking (the five-point test) (from very good to very bad) using ten professional evaluators. Data obtained from different experiments were analyzed statistically using factorial test based on complete random design in three replications. Five fruits were tested in each replication. To compare means of treatments, Duncan's test was used in 5% level and diagrams were designed using EXCEL.

RESULTS AND DISCUSSION

Decay percent of fruits treated by ascorbic acid was significant compared to controls and in both treatments, increasing concentration reduced decay percent (Table 1). Such occurrence can be attributed to effect of thymol and carvacrol available in essence of thyme that plays role in prevention of decay (Pires *et al.,* 2013). Anti-decay effects of thymol and carvacrol are due to permeability of cell membrane where cations on the surface are chelated and vital activities are controlled (Ultee *et al.,* 1999). Since ascorbic acid plays determinant role in inhibition of active species of oxygen and diffusion of extreme radiations of sunlight (Loggini *et al.,* 1999), decay reduction percent in treated fruits can be attributed to antioxidant features of ascorbic acid (protection of cellular macromolecules such as proteins, lipids and DNA against free radicals). Results indicated that the increase in amount of concentration of ascorbic acid and thyme causes the reduction percent in fruit weight. In treatments of thyme, no significant differences were observed, but in treatments of ascorbic acid, there were significant differences between different concentrations (Table 1).

Table 1: Effects of treatments of thyme and ascorbic acid on physical characteristics of quince fruit.

Treatment	Decay percent	Fruit weight reduction percent
Ascorbic acid control	28.33^{ab}	9.6^{ab}
Ascorbic acid (1 ppm)	25^{bc}	9.01^{ab}
Ascorbic acid (2.5 ppm)	20^{c}	10.66^{a}
Ascorbic acid (5 ppm)	10^{d}	6.99^{b}
Thyme control	33.3^{a}	8.36^{ab}
Thyme (25 vol %)	10^{d}	8.98^{ab}
Thyme (50 vol %)	6.6^{d}	11^{a}
Thyme (100 vol %)	4.33^{d}	10.27^{a}

Researchers believe that weight reduction of harvested fruits in optimum growth stage is lower than fruits that were harvested early or late (Elgar *et al.,* 1999). Concerning that such fruits were harvested in commercial ripening stage in the same hour and day, it can be said that non-significant difference of weight reduction of controls has been reasonable.

Mean comparison of effects of different concentrations of ascorbic acid and thyme on total soluble solids showed that the increasing concentration of ascorbic acid and thyme increased the value of T.S.S. (Table 2). The increasing dissolved solids are due to break of polymeric carbohydrates to small water-soluble molecules during ripening. Such results are similar to results obtained by Varela *et al.,* 2007. Total sugar and reducing sugars are increased by breaking carbohydrates especially starch to sugars and conversion of acids to sugars. Since amount of sugars has direct relationship with solids, the increasing dissolved solids suggests increase of sugar in treated fruits. Amounts of acidity reduced during ripening of quince fruit and during storage. Quince fruit, like an apple, is climacteric and respiration process continued during storage and organic acids are reduced due to reaching respiration effect or when changing into sugars (Paul and Pandey, 2014). The highest amount of acidity belongs to control ascorbic acid. Amount of acidity was reduced by applying both ascorbic acid and thyme treatments and such reduction in thyme treatment is evident with significant difference (Table 2). Regarding the effect of ascorbic acid treatment on fruit acidity, amount of acidity of control fruit was reduced with significant difference from 0.58 to 0.35 in 5 ppm ascorbic acid. Changes of fruit sensing characteristics have been shown in table 3. Mean comparison of effect of different concentrations of ascorbic acid and thyme on apparent shape and tissue consistency index, color index and amount of browning indicated that there was no significant difference in such effect on apparent shape, tissue consistency index, color index and browning amount but treatments of thyme essence reduced apparent shape of fruit, tissue consistency index, color index and increased browning amount. Reduction of tissue consistency can be due to conversion of starch to dissolved sugars. It is assumed that reduction in amount of respiration caused by ascorbic acid treatments which prevents increase in concentration of ethylene that has a direct relationship with amount of respiration leading to protection of tissue consistency. Browning is physiologically the most important disorder that reduces apparent quality, color, adore, flavor, tissue consistency and nutrient value of the fruit. Reduction of browning in fruits treated by ascorbic acid can be due to reduction of respiration, ethylene and activity of polyphenol oxidase enzyme. ANOVA showed that the effect of ascorbic acid and thyme treatments were significant on flavor index in 1% level (Table 3).

Table 2: Effects of treatments of thyme and ascorbic acid on chemical characteristics of quince fruit.

Treatment	TSS	Acidity	Taste
Ascorbic acid control	3.33^{bc}	0.58^{a}	86.67^{a}
Ascorbic acid (1 ppm)	3.2^{cd}	0.25^{d}	86.67^{a}
Ascorbic acid (2.5 ppm)	2.86^{d}	0.4^{b}	83.33^{a}
Ascorbic acid (5 ppm)	3.7^{a}	0.35^{c}	85^{a}
Thyme control	3.3^{c}	0.3^{c}	78.33^{a}
Thyme (25 vol %)	3.6^{abc}	0.35^{c}	58.33^{ab}
Thyme (50 vol %)	3.96^{a}	0.25^{d}	28.33^{b}
Thyme (100 vol %)	3.73^{a}	0.25^{d}	26.67^{b}

Table 3: Variance analysis of the effect of experimental treatments on quince fruit sensing evaluation.

Mean squares						
Source of changes	**df**	**Fruit consistence**	**Taste and flavor**	**Browning amount**	**Fruit shape**	**Fruit color**
Treatment	7	1597.470*	2009.524**	4217.708**	2135.524*	3652.548**
error	16	419.792	369.792	63.542	574.542	182.625
Coefficient of changes %		20.26	28.84	18.48	27.65	23.07

* and ** show significant difference in 5 and 1% levels respectively.

Mean comparison of effect of different concentrations of ascorbic acid and thyme treatments on flavor and taste indices showed that there were no significant differences between treatments of ascorbic acid regarding flavor and taste indices but treatment of thyme essence reduced flavor and taste indices such that in 50 and 100vol% of thyme, flavor and taste indices were obtained as 28.33 and 26.67, respectively. In concentrations of 1, 2.5 and 5 ppm of ascorbic acid, flavor and taste indices were higher and they were 86.67, 83.33 and 85 respectively, thus there was no significant difference (Table 2).

Protection of flavor and taste in fruits treated by ascorbic acid can be due to controlling water and respiration reduction and adverse effect of thyme essence on sensing characteristics especially fruit flavor and taste can be due to aromatic quince and aromatic compounds in thyme essence. Obtained results indicated that like other climacteric fruits, quince is accompanied with physicochemical changes. Application of ascorbic acid treatment is more favorable than control and thyme treatments samples due to reduction of decay percent, weight reduction, protection of chemical compounds and favorable color, shape, flavor and taste. As a result, positive results of using ascorbic acid in reduction of storage damages were specified.

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