

Effects of Extended Storage on Bitter Orange Quality Factors

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Abstract: The objective of this research was to determine the effects storage time on some quality parameters of bitter orange. In this study Physical, chemical and sensory properties were monitored at 4°C for 18 days. pH, DL, WHC, shear force values, microbial contamination and sensory Characteristics were determined. Bitter oranges were sanitized, peeled, segmented and packed in polyethylene (PE) trays. The study indicated that time storage had no significant effect ($p>0.05$) on pH with samples stored at $4\pm 1^\circ\text{C}$. shear force increased over time but not significantly ($p<0.05$). DL increased over time while WHC decreased during storage. In summary, packaging of fresh bitter orange accompanied by refrigeration storage enhanced product shelf life for 12 days without undesirable and detrimental effects on its sensory acceptability.

Keywords: Bitter orange, low temperature, polyethylene packaging, shelf-life, WHC

INTRODUCTION

Bitter orange (*Citrus aurantium*) is a plant that belongs to the Rutaceae family. It also called Seville orange, is known botanically as *Citrus x aurantium* L. and sometimes by its taxonomic synonyms, *C. aurantium* L. subsp. *aurantium* and *C. aurantium* subsp. *amara* (L.) Engler (Blumenthal, 2005). It is presently commercially cultivated in southern Europe and other sub-tropical areas, particularly Spain, Portugal, Israel and the various islands of the Caribbean (Bisset and Wichtl, 1994). In the food industry, bitter orange oil, which is usually expressed from the fresh peels, is widely used as a flavouring agent. Bitter orange oil is used as flavourings for beverages, particularly liqueurs and to intensify the orange character of soft drinks (Colombo *et al.*, 2002). The Food and Drug Administration (FDA) has approved bitter orange (in small amounts) as a flavouring agent. In manufacturing, bitter orange is used in cosmetics and soaps (Jeff, 2002). Even though Iran has been among the oldest citrus-producing countries of the world, unfortunately, there has not been much progress achieved either in its industrial processing or in its export qualities, causing it not to be of a favourable standing in the international markets. Fruit packaging installations have been founded in five northern cities of Ramsar, Shahsavar, Noshahr, Chaloo and Amol to process and pack citrus in advanced modern ways, but packaging is not yet done in the most suitable

and proper way. Grading and sizing of fruit is a pre-requisite to proper packaging, but not much importance has been attached to its study (Anonymous, 2005). There is no suitable set of standards for grading and sorting of fruits. There does not exist any suitable set of standards for grading and sorting of the fruit in Iran (Sharifi *et al.*, 2007).

Several studies have been published concerning the Physico-Chemical Changes during Storage of Orange Juices (Supraditareporn and Pinthong, 2007), Fresh cut pears (Senesi *et al.*, 1999) and kiwifruit (Agar *et al.*, 1999). No data have been published on the changes of bitter orange characteristics during storage time. Our objective was to investigate the Effects of Storage Time on the quality parameters of bitter orange samples and to determine the quality losses for 18 days at 4°C under refrigeration.

MATERIALS AND METHODS

Sample preparation: Ripe fresh bitter orange fruits (*Citrus aurantium*) were used for all the experiment in this study. The fruits were collected from Shahsavar province, Iran in September 2009. The bitter oranges (*Citrus aurantium*) harvested and forced air cooled before the experiment was set up. Polyethylene (PE) packaging rolls were used for preparation of packages of 30 cm × 20 cm. All equipment was sanitized using 300 ppm chlorine

Table 1: Values (means±SEM) of some characteristics of bitter orange preserved in low temperature during storage time

| Time/treatment | Firmness (N) | pH | TSS (%) | Sucrose (%) | Titrateable acidity (% citric acid) | Vitamin C (mg/±10 mg/L) |
|----------------|----------------|----------------|-------------|-------------|-------------------------------------|-------------------------|
| Day1 | 18.01±9.878 b | 3.14±0.064abc | 7.00±0.000a | 5.51±0.343a | 1.67±0.135c | 258 |
| Day6 | 18.11±6.334 b | 3.15±0.071a | 6.70±0.000b | 6.02±0.556a | 1.87±0.011a | 208 |
| Day 12 | 20.24±6.956 ab | 3.13±0.025abcd | 7.00±0.000a | 5.83±0.297a | 1.70±0.145abc | 190 |
| Day 18 | 23.94±4.211 a | 3.06±0.042cd | 7.00±0.000a | 5.95±0.189a | 1.70±0.055abc | 183 |

^{a, b, c}: values in the same column with different superscript are significantly different (p<0.05)

Table 2: Sensory attributes of bitter orange preserved in low temperature during storage time

| Time/treatment | Appearance | Odor | Texture | Acidity |
|----------------|-------------------------|-------------------------|------------------------|--------------------------|
| Day 1 | 4.5±0.224 ^a | 4.6±0.492 ^a | 4.7±0.82 ^a | 4.0±1.327 ^{ab} |
| Day 6 | 4.5±0.321 ^a | 4.0±1.391 ^{ab} | 4.7±0.43 ^a | 4.5±0.485 ^a |
| Day 12 | 4.2±0.210 ^{ab} | 4.1±0.570 ^{ab} | 4.4±1.02 ^{ab} | 4.3±1.672 ^a |
| Day 18 | 3.9±0.454 ^{ab} | 4.0±0.520 ^{ab} | 3.7±0.10 ^{ab} | 3.0±1.080 ^{abc} |

^{a, b, c, d}: values in the same column with different superscript are significantly different (p<0.05)

solution prior to processing. Fruits were selected for uniformity, washed with tap water and immersed in 200 ppm NaOCl for 3 min., then dried and peeled manually. In this study normal atmosphere (normal), was applied with the packaging machine (200A). After the experiment was set up, fruits were stored in a cold room maintained at 4°C, for 18 days. Quality parameters were evaluated after 0, 5th, 10th and 20th days. Sensory analysis (Tas, 2007) was performed at 0, 10th and 20th days. All analyses were performed in the laboratory of Tehran University, Department of Food Science.

Chemical and physical analysis: Fruit flesh firmness was assessed using a texture analyzer. Speed of 20 mm/s and penetration distance of 13 mm was used to cut the segments at the centre and the firmness was expressed as maximum cutting force (N). The segments similar in thickness were selected for firmness measurement. Six segments from two parallel packages (10 segments/package) were measured for each treatment on each sampling day (Tas, 2007). The readings were recorded in N force. The storage duration was determined for each treatment. All chemical properties of the bitter orange were investigated on randomly selected 50 fruit samples. The nutritional composition of the orange fruits juice was studied as explained below: Total dry matter, water soluble dry matter and pH of the samples were determined according to the methods of AOAC (1990). Each sample (about 25 g from) was blended for 3 min. and filtered by using cheese cloth. The prepared juice of the sample was used for chemical analysis. The acidity was measured by titration with 0.1 N NaOH (AOAC, 1984). Results were expressed as per cent citric acid. Total Soluble Solid contents (TSS) were determined by extracting and mixing two drops of juice from the two cut ends of each fruit into a digital refractometer at 23°C and the result expressed as Brix (AOAC, 1984). The juice of the sample was centrifuged at 3000 rpm for 10 min. and the supernatant was filtered by using a 0.45-µm-pore size filter to determine sugar content (fructose, glucose, sucrose and total sugar) of bitter orange segments by using a HPLC equipped with refractive index detector (Escalona *et al.*, 2005). Chemical analysis was repeated twice for each

package and the average of four measurements of two parallel packages were calculated (Tas, 2007).

Sensory analysis: Bitter orange samples were evaluated for overall appearance, firmness, aroma and acidity using a 5-point rating scale with six trained panelists. The attributes and product acceptability were expressed as follows: Visual appearance 5: excellent/fresh; 4: good; 3: acceptable; 2: poor; 1: very poor. Aroma 5: natural; 4: loss of aroma; 3: no aroma; 2: light strange aroma; 1: strong strange aroma. Firmness 5: excellent firmness/juiciness; 4: firm/ juicy; 3: acceptable firmness/juiciness; 2: hard; 1: very hard. Acidity 5: very good; 4: good; 3: acceptable; 2: acidic; 1: too much acidity. (Karacay and Ayhan, 2009). The data were analyzed using analysis of variance to determine the effects of storage time on the parameters of meat quality: pH, DL and SF. When the differences among types of storage time were significant (p<0.05), Tukey's test was carried out to check the differences between pairs of groups. Data were analyzed using the SAS (1988) statistical package (SAS, 1988).

RESULTS AND DISCUSSION

Physical quality of bitter orange segments firmness: Many factors contribute to the eating quality of meat and the perception of taste, with tenderness being considered as one of the most important attributes (Wheeler *et al.*, 1990; Koohmaraie *et al.*, 1991). An objective measure of tenderness is the force required to shear a standardized piece of meat with low shear values being desirable. The tensile strength test is best suited for structural investigations rather than to predict sensory evaluation of tenderness. Shear forces data are shown (Table 1). Storage time affected segment firmness significantly (p<0.01). Firmness values were 18.01(N) for bitter orange samples on first day, Increases in firmness values were observed in the first five days of storage and tended to reverse for the rest of the storage at all applications. Increase in firmness may be attributed to surface drying of the segments due to water loss by respiration and transpiration as stated by Martin-Bellaso and Soliva-

Fortuny (2006) and Erkan and Wang (2006). However, our sensory panel did not find significant changes in firmness during storage.

Chemical quality of bitter orange segments: Important chemical properties such as titratable acidity, pH, soluble solids and sugar content of the bitter orange segments are shown in Table 1. The storage time also did not have significant effect on titratable acidity ($p = 0.8361$) and pH ($p = 0.052$). However, there was significant effect of storage time on total soluble solids ($p < 0.001$). The sugar content (fructose, glucose and total sugar) of bitter orange segments did also not change significantly during storage ($p > 0.05$). Studies with freshcut pears (Senesi *et al.*, 1999) and kiwifruit (Agar *et al.*, 1999) showed that sugar content did not significantly change under refrigerated storage, as expected because sugar content is not much influenced by the atmospheric conditions (Soliva-Fortuny and Martin-Belloso, 2003). Our results are in agreement with the results by Pretel *et al.* (1998) who reported no significant changes in chemical attributes (pH, titratable acidity and soluble solids) during 11 days of storage of minimally processed oranges (Pretel *et al.*, 1998). After 20 days of storage, vitamin C losses in bitter orange stored were by 32% lower. Thus limitation of oxygen diffusion by PE packaging would have had a limited positive effect. These results show that use of PE packages with good oxygen barrier properties had impact against vitamin C losses.

Sensory quality of bitter orange segments: The results of the sensory evaluation are presented in Table 2. There was no significant effect of MAP treatment storage time interaction on any of the attributes tested ($p > 0.05$). Bitter orange segments packaged under air were found acceptable for 18 days in terms of sensory quality; the atmosphere was anaerobic after the 15th day which could be risky for consumption. The scores for bitter orange segments treated with high oxygen were below acceptability limit (score 3) at the 18 days of storage for most of the sensory attributes and the product acceptability. The bitter orange segments were viable for less than 12 days for passive due the internal atmosphere at 4°C. High oxygen application provided further advantages over normal packaging after 18 days of storage. Bitter orange segments can be prepared as ready-to eat fruits with considerable shelf-life of 12 days, good quality and convenience to the consumer using PE trays.

CONCLUSION

Bitter orange segments can be prepared as ready-to eat fruits with considerable shelf life of 15 days, good quality and convenience to the consumer using PE trays. PE packages with good oxygen barrier properties had

impact against vitamin C losses. This study could be repeated using packaging film with higher permeability to increase the shelf life more than 12 days. In this study we have observed the evolution of the main parameters that affect bitter orange quality (pH, Vitamin C, Sucrose, TSS, Titratable acidity and shear force). In general, there were no differences among samples for pH. Tenderness increased during the time. In summary, packaging of fresh camel meat accompanied by refrigeration storage enhanced product shelf life for 12 days without undesirable and detrimental effects on its sensory acceptability.

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