International Journal of Horticultural Science and Technology
Vol. 6, No. 2; December 2019, pp 159-165
Print ISSN: 2322-1461 Online ISSN: 2588-3143
DOI: 10.22059/ijhst.2019.284379.302
Web Page: https:// ijhst.ut.ac.ir, Email: ijhst@ut.ac.ir

Effect of Maturity Stage of Olive Fruit on Quality of Olive Products

Azhar Hussain[1*], Muhammad Ashraf Sumrah[1], Attiq Akhtar[2], Seyed Hamza Mahfooz[1] and Muhammad Azeem Tariq[1]

1. Barani Agricultural Research Institute, Chakwal, Pakistan

2. Horticultural Research Station Nowshera (Khushab), Pakistan

(Received: 28 June 2019, Accepted: 24 October 2019)

Abstract
This is the first-ever study conducted to standardize the maturity stage of olive fruit for development of olive *murabba*. Olive fruit was harvested at three different maturity stages including lemon green, semi-ripened and fully ripened stages for postharvest processing. Most prominent quality parameters of the product were studied for all maturity stages. Olive product prepared from semi-ripened fruit gave the best score for the olive appearance (7.00) followed by that from lemon green stage (4.64). Semi-ripened stage also scored top in terms of flavor (6.53) and taste (6.58), followed by lemon green stage with non-significant differences. Highest firmness (14.91N) and shelf-life (372.66 days) were detected in products prepared from the lemon green stage; followed by semi-ripened stage (12.19 N firmness and 263days shelf life). Fruits harvested at fully ripened stage remained at the bottom in terms of all the parameters studied. The product prepared from fruits at semi-ripened stage gained the best acceptability due to having of the best appearance, flavor and taste, which are the main quality attributes in consumer viewpoint. In conclusion, harvesting olive fruit at semi-ripened stage resulted in the best quality of olive for processing to *murabba*.

Keywords: Olive processing, FS-17, *Murabba*, shelf-life, taste, firmness.

Introduction

Olive (*Olea europaea* L.) has a long history of its popularity. Fruit of olive has great importance due to nutritional value and medicinal properties (Haloui et al., 2010). It has been utilized for the treatment and prevention of various ailments including cancer (Owen et al., 2004) and cardiovascular diseases (De Lorgeril and Salen, 2006). Due to rising knowledge about the health benefits of olive, the consumption of this fruit and its products has greatly increased not only in the developed world but also in the developing countries (Vinha et al., 2005). The traditional "Mediterranean diet", that contains the olive oil as an important component, is considered to be among the best ones for having strong connection with the reduced incidence of heart diseases and certain cancers (Owen et al., 2004).

Olive is mainly grown for oil production, however, a reasonable quantity of table olives are produced for development of various olive products such as preserves and other culinary objectives (Aldalas, 2005; Su et al., 2018). Due to bitterness, it cannot be utilized in raw form; however, after processing, it can be utilized for table purposes besides olive oil.

[*] Corresponding Author, Email: azharhort@yahoo.com

Oleuropein is the constituent that makes the fruit bitter (Tayoub et al., 2012) and needs to be removed to make it palatable.

Advancement of olive processing technology has resulted in higher returns as compared to olive oil production; as a result, production of table olive varieties is increasing day by day. Cultivation of olive is increased during the last few decades due to its wide range of adaptability to soil, climatic conditions and development of various varieties for different agro-climatic conditions. Quality of fruit is determined by the stage of maturity or the ripening. Typical assessment of fruit maturity includes measurement of sugars, acidity, color, taste, flavor and firmness of the fruit (Mohebi et al, 2017). The optimum harvesting time of the fruit should guarantee best quality of olive fruit at the right stage of maturity for processing as black or green olives. Olive harvesting begins when fruit color changes from dark green to pale green for different products and continues until the color is changed to black or purple. The harvesting time has a crucial role in fruit quality (Moradinezhad et al., 2016).

Studies on the quality of olive product are found very rarely, whereas a lot of work on other fruits has been carried out and published in the past. Fruit selected for product processing should be harvested at the right stage of maturity to get excellent results for taste, firmness, flavor and texture of the product. Harvest maturity significantly affects the level of flavor volatiles (Barrett et al., 2010) and is the second most important factor (after genotype) influencing flavor quality of the fruits (Kader, 2008).

Aroma, texture and taste of the product basically depend on the maturity of the fruit. Most of the non-fruity vegetables having their best taste when harvested immature; while many of the fruity vegetables and other fruits having best taste when harvested at fully ripen stage (Kader, 2008). William (1990) recommends choosing juicy but ripe fruit for best quality of *murabba*. Patel et al. (2014) prepared the Amla *murabba* by processing of freshly harvested matured fruit. To ensure the highest quality at the end of long-term storage, apples must be harvested when mature but not yet fully ripe (Rutkowski et al., 2008).

Very limited scientific information is available about the assessment of harvesting time of olive fruit for development of specific products like *murabba*, which is a popular nutrient rich product of table olives in Indo-Pak subcontinent and is cherished for its delicious taste and peculiar flavor. Keeping in view the requirement of practical recommendation, the current research study was conducted to standardize the maturity stage of olive fruit for product development.

Materials and Methods

Olive fruit of cv. FS-17 was harvested in September, during each experimental year (2016, 2017 & 2018) at lemon green, semi-ripened and fully ripened stages. The fruit was collected in perforated plastic containers, washed and cleaned for removal of dust and other residues. It was then treated with 20% Brine solution for removal of fruit bitterness. The fruit was then graded to remove all damaged, discolored and soft fruits from the experimental materials. Selected fruit was thoroughly rinsed and air dried for three h to remove excessive moisture.

For the preparation of *murbba*, the selected fruit was kept dipped in different levels of sugar solutions (Anonymous, 2013). Initially, it was dipped in 15^{o} Brix sugar solution for 24 h. The sugar solution strength was measured with a hand refractometer (Abbe® model 10450). The fruit dipped in sugar solution was removed and the sugar solution was boiled for 15 min after adding more sugar making the final solution strength to 20^{o} Brix. After cooling of the sugar solution, the fruit was again dipped in freshly strengthened sugar solution for 48 h. This process was again repeated after making the sugar solution

strength at 30° Brix. After dipping the fruit for 48 h it was removed from the sugar solution to bring the solution to a final concentration of 60° Brix by boiling and by addition of more sugar. Citric acid at 2g/L solution and sodium benzoate at 1g/L solution were added in the syrup as a preservative. Treated fruit was dipped in the prepared sugar syrup after cooling at room temperature for final packing in cleaned and sterilized 250 mL glass jars. The filled jars and lids were exhausted at 80 °C for 15 min before final sealing of jars. Sealed jars were stored at room temperature for 30 d before evaluation.

The firmness of the product prepared from fruit harvested at different maturity stages was recorded by a Wagner® Fruit Firmness Tester, model FT-327. Six samples from each treatment were tested.

Appearance, flavor and taste were judged by analytical sensory evaluation method (IFT, 1981). An expert sensory evaluation panel was constituted comprising of ten members including females and males of various age groups for testing and recording of the data. The panelists were trained for aroma and taste of olive fruit before evaluation day. Samples of each treatment were given the code numbers and a hedonic sensory evaluation of individual sample was made and scored by the panelists. The judges were not allowed to discuss with each other the assessment of any sample. Three formulations were prepared for analysis. The first formulation was the product made from light green color olive fruit denoted by T-1, second formulation was the product made from semi-ripened olive fruit denoted by T-2, while the third formulation was that prepared from fully ripened olive fruit denoted by T-3.

The evaluation of samples was done in three consecutive sessions. The panelists were requested to be careful to evaluate the product sample using an eight-point hedonic scale ranging from highest (excellent) by 8 to lowest (extremely poor) denoted by 1. The samples were marked by a code number and were served simultaneously to each panelist. To avoid bias, the participants were not provided with any product information. The judges were requested to test only one sample at a time for an accurate rating of the sample and eat a piece of bread, wash the mouth with fresh, clean water at room temperature, as palate cleaner before tasting the next sample.

The shelf-life of the product was assessed according to a model developed by IFT (1974). Shelf-life was counted in days starting from final packing to the last evaluation day by observing the symptoms of spoilage (i.e. change in aroma, taste, color, and development of visible pathogen indication like fungus and etc.).

The experiment was designed according to completely randomized design in triplicate with eight replications of three treatments i.e. lemon green color, semi-ripened fruit of lemon green color with purple tinge and fully ripened fruit with deep purple color. The data were recorded bimonthly for different quality parameters. Treatment means were calculated from six readings during the study period. Data were subjected to analysis of variance (ANOVA) and significant differences among means were detected at $P<0.05$ using LSD test.

Results

Appearance

The results depicted in Table 1 showed that semi-ripened stage of olive remained the best with a score in appearance (7.00) followed with significant difference by the lemon green stage and fully ripened stage, which had a score of 4.64 and 4.24, respectively. Product of fully ripened fruit gave a dark appearance due to blackish color of fruit at that stage and did not give an attractive look. Fruit harvested and processed at lemon green stage gained a dull appearance, which was also not fine-looking for the consumers. On the other hand, the fruit harvested at semi-ripened stage gave an eye-catching appearance on processed fruits. The attractive appearance

of the product has a positive impact on its marketing.

Flavor

The results showed that maximum score in flavor (6.53) was recorded in the product of semi-ripened fruit as shown in Table 2. It was followed by lemon green stage having a score of 4.77. The flavor of fully ripened fruit after processing scored 3.99 points and differed significantly from semi-ripened stage of maturity. This might be due to the metabolism of phenol compounds and volatiles in flavor of the fruit during the ripening process. Fruit harvested at semi-ripened stage was much liked at processing and gained the best score due to its best flavor.

Taste

The results (Table 3) showed that olive product of semi-ripened fruit gave best taste score (6.58) as compared to that prepared from the fruit harvested at lemon green and fully ripened stage (5.53 and 3.39 respectively). This might be explained by the fact that accumulation of nutritional and polyphenolic compounds occurred at semi-ripened and fully ripened stages while these compounds are less in the lemon green stage of maturity. The metabolism at fully ripened fruit stage resulted in deterioration of quality parameters of the fruit products. The results revealed that olive *murabba* can be prepared with the best taste when harvested at semi-ripened stage.

Firmness

It was revealed that maximum firmness (16.91 N) was recorded when the olive fruit was processed at the lemon green stage of maturity which showed significant difference from rest of the treatments (Table 4). Semi-ripened and fully ripened fruit, after processing, had a firmness value of 12.19 N and 10.88 N, respectively. Both these treatments remained at par with each other. This may be due to breaking down of phenolic compounds and the glycosides during the ripening process of the fruit resulting in a reduction of fruit firmness. Too much or too less firmness is not desired for good quality of *murabba* because greater firmness gives an un-ripened texture while more softness gives an effect of over-ripening, which is not liked by the consumers. It was found that best and desirable firmness was obtained in case of olive fruit harvested at semi-ripened stage of maturity.

Shelf-life

The data regarding shelf-life showed that maximum shelf-life (372.66 d) was recorded in the product prepared from fruit harvested at lemon green stage of maturity (Table 5). Shelf-life of 263 d was recorded when fruits harvested at semi-ripened stage were processed. It was followed by the product of fruits harvested at fully ripened stage, which showed a shelf-life of 185.67 d. All treatments differed significantly from each other.

Table 1. Effect of maturity stage of olive fruit on sensory score (Hedonic Scale) of product appearance

Treatment	2016	2017	2018	Means
Lemon green	4.45^{ab}	4.31^{b}	5.07^{ab}	4.64^{b}
Semi-ripened	6.76^{a}	7.87^{a}	6.38^{a}	7.00^{a}
Fully ripened	3.95^{b}	4.91^{b}	3.87^{b}	4.24^{b}
LSD	2.78	2.10	2.25	2.31

Same letter in the same column indicates no significant difference at the level of 5% significance

Table 2. Effect of maturity stage of olive fruit on sensory score (Hedonic Scale) of product flavor

Treatment	2016	2017	2018	Means
Lemon green	4.93^{ab}	5.01^{ab}	4.37^{ab}	4.77^{ab}
Semi-ripened	6.56^{a}	6.87^{a}	6.18^{a}	6.53^{a}
Fully ripened	3.75^{b}	4.93^{b}	3.07^{b}	3.99^{b}
LSD	1.70	1.88	2.27	1.91

Same letter in the same column indicates no significant difference at the level of 5% significance

Table 3. Effect of maturity stage of olive fruit on sensory score (Hedonic Scale) of product taste

Treatment	2016	2017	2018	Means
Lemon green	5.06[ab]	5.62[ab]	5.93[ab]	5.53[ab]
Semi-ripened	6.43[a]	6.95[a]	6.37[a]	6.58[a]
Fully ripened	3.62[b]	3.13[b]	3.45[b]	3.39[b]
LSD	2.60	2.50	2.50	2.52

Same letter in the same column indicates no significant difference at the level of 5% significance

Table 4. Effect of maturity stage of olive fruit on firmness (Newton) of the product

Treatment	2016	2017	2018	Means
Lemon green	15.68[a]	17.39[a]	17.66[a]	16.91[a]
Semi-ripened	13.72[b]	11.[19b]	11.68[b]	12.19[b]
Fully ripened	13.52[b]	9.94[b]	9.19[b]	10.88[b]
LSD	1.87	2.22	1.73	1.89

Same letter in the same column indicates no significant difference at the level of 5% significance

Table 5. Effect of maturity stage of olive fruit on the shelf-life (days) of the product

Treatment	2016	2017	2018	Means
Lemon green	365[a]	380[a]	373[a]	372.66[a]
Semi-ripened	260[b]	268[b]	261[b]	263.00[b]
Fully ripened	185[c]	190[c]	182[c]	185.67[c]
LSD	20.07	21.21	19.51	20.35

Same letter in the same column indicates no significant difference at the level of 5% significance

Discussion

Results of our study have depicted that semi-ripened stage of maturity is the best time as it had the highest score in terms of the most important parameters (such as appearance, flavor, taste and firmness) associated with the consumers' preference. Semi-ripened stage of maturity ranked second only for the shelf-life. A number of studies have been conducted in the past regarding proper maturity stage of various horticultural commodities including fruits and vegetables. This is the first-ever study regarding maturity stage of olive fruit for its processing as *Murabba*. We have obtained the best results when the olive fruit was harvested at semi-ripened stage of maturity.

The best preserve is made from fully mature fruits that are at the hard stage (Dalal et al., 2019). Tripathi et al. (1988) has also mentioned that fruit should be firm ripe and uniform in size for evenly cooking or processing. Degeneration of fibrous tissues of fruits is known to be accelerated by the ripening process (Sharma and Singh, 2000). This degeneration is likely to affect the quality of fruit that may ultimately make the product unpleasant or less acceptable by the consumers.

Ripe fruits are not suitable since the structure will be too soft to form a product of good quality (Dalal et al., 2019). The semi-ripened fruit is more preferable for better quality product as compared to fully ripened fruit (Anju et. al., 2000). In a previous study conducted on *amla*, un-ripened green fruit and fully ripened fruit resulted in poor quality while mature, semi-ripened fruit produced best quality product (Sethi and Anand, 1993). Fouad and Yuli (1988) and Thompson (1996) also reported that shelf-life of the products decreased as the fruit progressed towards ripening. To ensure maximum resistance to mechanical damage and good shelf-life, fruits are usually harvested well before physiological ripening, and at a stage characterized by high flesh firmness (Moradinezhad et al., 2016). Similar results have been reported by Anju et al. (2000).

Knowledge on the degree of fruit ripeness is significantly important to growers to decide about the best time to harvest in order to get the best quality (Moradinezhad et al., 2016). Harvest maturity of fruits and vegetables should have its maximum acceptable quality parameters such as aroma, color, firmness and shelf-life (Thompson, 1996). Many of the factors are interdependent, which can be influenced by seasonal and growth stages, maturity difference, postharvest drying and storage conditions (Hassanzadeh et al., 2017). When the olives are harvested late, the final product is soft and preservation is bad, therefore the best stage to harvest has a direct effect on final quality (Abbasi et al., 2006). Harvesting of olives is a very important step for determining the quality of olives especially when they are planned to be processed for *murabba*, hence they must be harvested at the right stage (based on the result of the present study at semi-ripened stage) after attaining the full size.

Conclusion

Olive fruit harvested at semi-ripened stage gave the best results for most of the quality parameters of consumers' preference such as appearance, flavor, taste and firmness of the product. Product prepared at this stage of fruit maturity showed the best quality and consumers' acceptability of the product. It is, therefore, concluded that the olive fruit should be harvested at the semi-ripened stage if the intended use is its processing for olive *murabba*.

References

1. Abbasi N.A, Hafiz I.A, Ahmad T, Maqbool M. 2006. Value added products of the table olive. International Conference on value addition in hort. product. 26-28 June. PMAS UAAR., Pakistan 279-285.
2. Aldalas M. 2005. Country report. Yemen. Workshop on Good Agricultural Practices for AARENINA. Olive Network Member Countries. Organized by the ARI. AARENINA and FAO/RNE.19-21, December. Larnaca, Cyprus.
3. Anju B, Shashi B, Somesh S. 2000. Preserves, candies, crystallized fruits and vegetables. Post harvest technology of fruits and vegetables. Indus Publishing company, New Delhi.
4. Anonymous. 2013. Standardization of olive propagation and its value addition techniques. Monitoring Report Punjab Agricultural Research Board 185, 48-57.
5. Barrett D.M, Beaulieu J.C, Shewfelt R. 2010. Color, flavor, texture and nutritional quality of fresh-cut fruits and vegetables: Desirable levels, instrumental and sensory measurement and the effects of processing. Critical Reviews in Food Science and Nutrition 50, 369-389.
6. Dalal N, Neeraj, Bisht V. 2019. Value added products from Ber. International Journal of Current Microbiology and Applied Sciences 8(1), 1603-1615.
7. De Lorgeril M, Salen P. 2006. The Mediterranean-style diet for the prevention of cardiovascular diseases. Public Health and Nutrition 9, 118-123.
8. Fouad M.B, Yuli C. 1988. Effect of harvest Date, Maturity and Storage intervals on post harvest Quality of Blue Berry. Proceedings of the Florida State Horticultural Society 101.
9. Haloui E, Marzouk Z, Marzouk B, Bouftira I, Bouraoui A, Fenina N. 2010. Pharmacological activities and chemical composition of the *Oleae uropaea* L. leaf essential oils from Tunisia. Journal of Food, Agriculture and Environment 8(2), 204-208.
10. Hassanzadeh K, Aliniaeifard S, Farzinia M.M, Ahmadi M. 2017. Effect of Phenological Stages on Essential Oil Content, Composition and Rosmarinic Acid in *Rosmarinus officinalis* L. International Journal of Horticultural Science and Technology 4, 251-258.
11. IFT. 1974. Shelf life of foods. Institute of food technologists. Expert panel on food safety. Food and nutrition. Journal of Food Science 39, 861.
12. IFT. 1981. Sensory evaluation guide for testing food and beverage Products. Sensory Evaluation Division. Food Technology 35(11), 50-59.
13. Kader A. 2008. Perspective flavor quality of fruits and vegetables. Journal of Science of Food and Agriculture 88, 1863-1868.
14. Mohebi M, Babalar M, Askari M.A, Talae A, Ahmadi A. 2017. Effects of harvest date on apple fruit quality at harvesting and after cold storage. Journal of Postharvest Technology 5(2), 29-36.

15. Moradinezhad F, Setayesh F, Mahmoodi S, Khayyat M. 2016. Physicochemical Properties and Nutritional Value of Jujube (*Ziziphus jujuba* Mill.) Fruit at Different Maturity and Ripening Stages. International Journal of Horticultural Science and Technology 3, 43-50.
16. Owen R.W, Haubner R, Wurtele G. 2004. Olives and olive oil in cancer prevention. European Journal of Cancer Prevention 13, 319-326.
17. Patel K.K, Gupta R, Kuchi V.S. 2014. Study of organoleptic quality on *aonla murabba* during storage. Asian Journal of Dairy and Food Research 33(1), 67-70.
18. Rutkowski K.P, Michalczuk B, Konopacki P. 2008. Nondestructive determination of 'Golden Delicious' apple quality and harvest maturity. Journal of Fruit and Ornamental Plant Research 16, 39-52.
19. Sethi V, Anand J.C. 1993. Fruit preserves and murabbahs. Advances in Horticulture. Fruit Crop. Vol. 4. K.L. Chada and O.P. Pareekh. Malhotra publishing house, New Delhi.
20. Sharma R.M, Singh R.R. 2000. Harvesting, post harvesting, handling and physiology of fruits vegetables. Post harvest technology of fruits vegetables. Indus Publishing Company New Delhi.
21. Su C, Sun J, Zhu W, Peng L. 2018. History, Distribution, and Potential of the Olive Industry in China: A Review. Sustainability 10(5), 1426.
22. Tayoub G, Sulaiman H, Hassan A.H, Alorfi M. 2012. Determination of Oleuropein in leaves and fruits of some Syrian olive varieties. International Journal of Medicinal and Aromatic Plants 2(3), 428-433.
23. Thompson A.K. 1996. Post harvest technology of fruits and vegetables. Black Wall Science London 410.
24. Tripathi V.K, Singh M.B, Singh S. 1988. Studies on comparative compositional changes in different preserved products of Amla (*Emblica officinalis*) var. Banarasi. India Food Packer. 42(4), 60-65.
25. Vinha A.F, Ferreres F. Silva B.M, Valentao P, Gonçalves A, Pereira J.A, Oliveira M.B, Seabra R.M, Andrade P.B. 2005. Phenolic profiles of Portuguese olive fruits (*Olea europaea* L.): Influences of cultivar and geographical origin. Food Chemistry 89, 561-568.
26. William A. 1990. Poaching Fruits. Complete guide to cookery. The Reading Digest Association Ltd., Berkeley Square, London.