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Oil Quality and Quantity of Three Olive Cultivars as Influenced by Harvesting Date in the Middle and Southern Parts of Jordan

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ABSTRACT

Olive fruits of three promising Jordan cultivars (Nabali, Improved Nabali and Abo-shoka) were harvested at different harvesting dates at two locations in order to investigate the influence of cultivar and harvesting date on oil quality. The olive fruits were harvested manually at 15 day intervals throughout the experiment period, starting in October 15, 2006. The results showed that with later harvesting there was an increase in oil content, acidity, peroxide value and average fruit weight, while there was a decrease in fruit moisture and chlorophyll content at both locations. Refractive index (at 25°C) remains almost constant. The olive cultivars did not respond similarly. At the Al-Mshaqar orchard, cv Improved Nabali had the highest peroxide value and moisture percentage, while cv Abo-shoka had the highest chlorophyll content and average fruit weight. The highest oil percentage (fresh weight basis) was obtained for Nabali. However, at Wadi-bin Hamad orchard, cv Improved Nabali had the highest acidity. Abo-shoka had the highest chlorophyll content, moisture percentage and average fruit weight. The highest oil accumulation was for Nabali. The result proved that olive cultivar and harvesting date combine together to influence oil quality and quantity. In the light of the results, it is concluded that the optimum harvesting date to obtain the best olive oil quality and quantity is dependent on location, cultivar and harvesting date. It could be recommended that the harvest be delayed to obtain both best quality and quantity. The current results indicate that the acidity and peroxide value of the three cultivars did not exceed the maximum limit for extra virgin olive oil.

Key Words: Olive oil; Harvesting date; Nabali; Improved nabali; Abo-shoka; Oil quality

INTRODUCTION

Olive trees are considered the most important fruit trees in Jordan. Olives are found almost all over the kingdom going from the highlands to the Jordan valley and the desert. In the highlands, olive trees are mainly rain-fed, while the desert olives are necessarily irrigated. The total production of olive oil in the kingdom is increasing from year to year with increasing growing areas. This illustrates the need to determine the quality of olive oil from a range of harvest times and cultivars to establish an optimum harvest time for commercial varieties.

Olive oil has a characteristically position among edible oils because of its pleasant flavor, palatability, stability and health benefits. The beneficial effects have been attributed to nutrients and other components that are found in the oil such as linoleic acid, vitamins, natural antioxidants and other natural elements of dietary importance. Additionally, oleic acid, serves to slow the penetration of fatty acid into the arterial walls, hence decreasing cardiovascular disease (Michilakis, 1992; Viola, 1983).

There is general agreement that high olive oil quality requires optimum time for harvesting good quality fruit although in-field determination of when to harvest can be very difficult. Numerous studies in the Mediterranean region have shown that the oil percentage increases dramatically during early fruit ripening (Salvador, 2001). Oil quality improvement is concurrent with increasing oil content but peaks and begins to decline, before maximum oil yield is reached (Tombesi *et al*., 1994). A better understanding of morphological, biochemical and physiological process that happen during ripening can help us to improve the commercial and qualitative characteristic of fruit.

Along with olive fruit ripening, several metabolic processes take place with subsequent variations on profiles of some compounds. These changes are reflected on the quality grade, sensorial characteristics, oxidative stability and/or nutritional value of the obtained product. Polyphenols, tocopherols, chlorophyll pigments and carotenoids are examples of compounds involved in this phenomenon as well as, the fatty acids and sterol composition (Gasparini, 2001).

The majority of olive oil produced (94%) is not of the best commercial quality (Lavee, 1996), as the fruit has not been picked at the optimal harvest time. Time of harvesting may have a significant effect on oil quality as well as, yield, oil stability and sensory characteristics (Salvador, 2001).

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According to Cimato (1988) harvesting must be done, when the oils is of the best quality and the highest level. There have been numerous studies on this subject in an effort to find parameters that make it possible to easily define this period. Olive oil quality is influenced by a great number of factors including the cultivar and the fruit maturity stage (Garcla *et al*., 1996; Kiritsakis, 1998; Zamora *et al*., 2001; Rotondi *et al.,* 2004).

Optimal harvesting time is the most important factor that determines the olive oil quality and quantity. In fact, most olives are harvested at a late stage of maturity, when decaying processes are already going on in the fruit and the harvested olives are usually stacked in plastic bags, where they are left for long period before being processed. The objectives of this study were to determine the influence of harvesting date and cultivar on olive oil quality and quantity and to determine the optimum harvest period for cv Nabali, Improved Nabali and Abo-shoka cultivars.

MATERIALS AND METHODS

This investigation was carried out at two locations; the first in a private orchard at Wadi-bin Hamad (Al-Karak) and the second was at National Center for Agriculture Research and Technology Transfer (NCARTT) orchard at Al-Mshaqar Agriculture Research station, (Madaba). Representative olive trees of own rooted *cvv* Nabali; Improved Nabali and Abo-shoka (those are grown extensively in Jordan) were used in this research. The trees were spaced 7 m X 7 m; trickle irrigated and received routine horticultural care (standard pest, disease, fertilizer & irrigation programs).

At the Al-Mshaqar orchard, the fruits were harvested at five different dates during 2006/2007. The first harvesting date was October 15, 2006 and final harvest date was December 15, 2006. There was a period of 15 days between harvest dates. At the private orchard at Wadi-bin Hamad (Al-Karak), the fruit were harvested at seven different periods during the season of the year 2006/2007. The first harvest date was October 15, 2006 and final harvest was January 15, 2007 with a period of 15 days between each harvest. About 4 kg of olive drupes were collected from each cultivar at each location and harvesting date, the fruits were picked up manually from olive trees.

Olive oil. In order to obtain a good quality olive oil, the selected drupes were healthy, clean and free from pests and diseases. No more than 48 h elapsed between harvesting and pressing to avoid the risk of fermentation and development of defects in the oil. Olive oil was extracted using soxhlet apparatus.

Quality measurements. Olive oil samples were analyzed for acidity, peroxide value, chlorophyll content, refractive index, moisture percentage and olive oil content (fresh weight basis). Acidity and peroxide value were measured according to the method of Sandia and Martinez (1997). Average fresh fruit weight was also measured at the dates of collection.

Statistical analysis. At each location, experimental treatments (cultivars & harvesting dates) were arranged in a randomized complete block design with three replications. For each replicate, 7 trees were used as sampling units for each cultivar. At each harvesting date, sampling was carried out using a different tree. Statistical assessments of differences between mean values were performed by the LSD test at P=0.05 according to Snedecor and Cochran (1980) using MSTATC statistical package (Michigan State University, East Lansing, MI).

RESULTS AND DISCUSSION

Olive oil acidity. The acidity of olive oil is considered a basic characteristic of the quality. The results reported in Fig. 1 show insignificant differences among Nabali, Improved Nabali and Abo-shoka cultivars in terms of olive oil acidity at Al-Mshaqar area. However, significant differences were found among the three mentioned cultivars at Wadi-bin Hamad. The cv Improved Nabali had higher acidity than other cultivars, while cv Abo-shoka had the lowest. The results were in agreement with those obtained for other olive cultivars by Tombesi *et al.* (1994), Pannelli *et al*. (1990) and Freihat *et al*. (2008). Significant variation in oil acidity was obtained at all ripening stages, for all cultivars. At the Al-Mshaqar location, the acidity increased with maturity in all cultivars. The acidity value on October 15, 2006 ranged from 0.19-0.28 and from 0.64-0.66 on December 15, 2006 for all cultivars. The interaction between olive cultivar and harvesting date at Wadi-bin Hamad had significant influence on olive oil acidity. The acidity of cv Nabali increased from 0.36 on October 15, 2006 to 0.89 on January 15, 2007, while it increased from 0.43 on October 15, 2006 to 0.89 on January 15, 2007 for cv Improved Nabali. The increase in acidity, while the fruits remained on the tree was caused by the activation of lipolytic enzymes present in the fruits (Martinez Suarez, 1973).

Olive oil peroxide value. Peroxide value is used as an indicator to reveal enzymatic and oxidative deterioration in oil (Barone *et al.*, 1994). It is also used to monitor production problems, which occur after harvest and during processing (Kiritsaki & Markakis, 1984). Peroxide value was significantly influenced by olive cultivar at both locations (Fig. 2). The peroxide value increased as the fruit matures. The maximum value obtained of peroxide value is below the limit (20 meq O_2/kg oil), set by ISO as a maximum limit for extra virgin olive oil (Al-Rousan, 2004). At Al-Mshaqar, the data indicates that the highest value of peroxide was observed on December 15, 2006, while the lowest value was on October 15, 2006. Nabali had a highest peroxide value, while Abo-shoka was the lowest. Concerning Wadi-bin Hamad area, the interaction between olive cultivar and harvesting date significantly influenced the peroxide value. The peroxide value of Nabali increased from 4.40 on October 15, 2006 to 10.4 on January 15, 2007. The peroxide value of Improved Nabali increased

Fig. 1. Olive oil acidity of three cultivars at different harvesting dates at Al- Mshaqar and Wadi-bin Hamad orchards

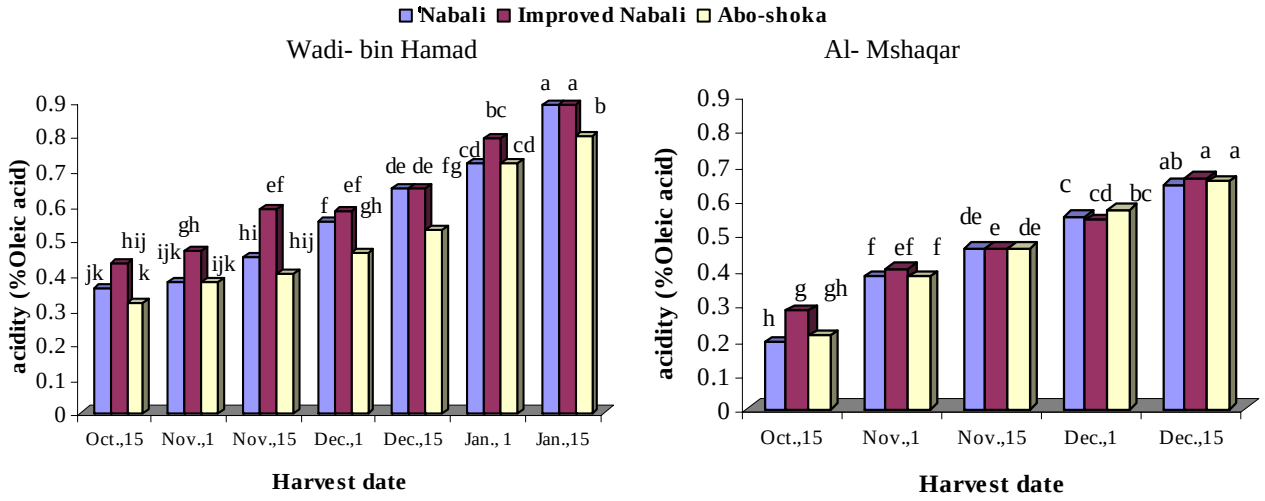
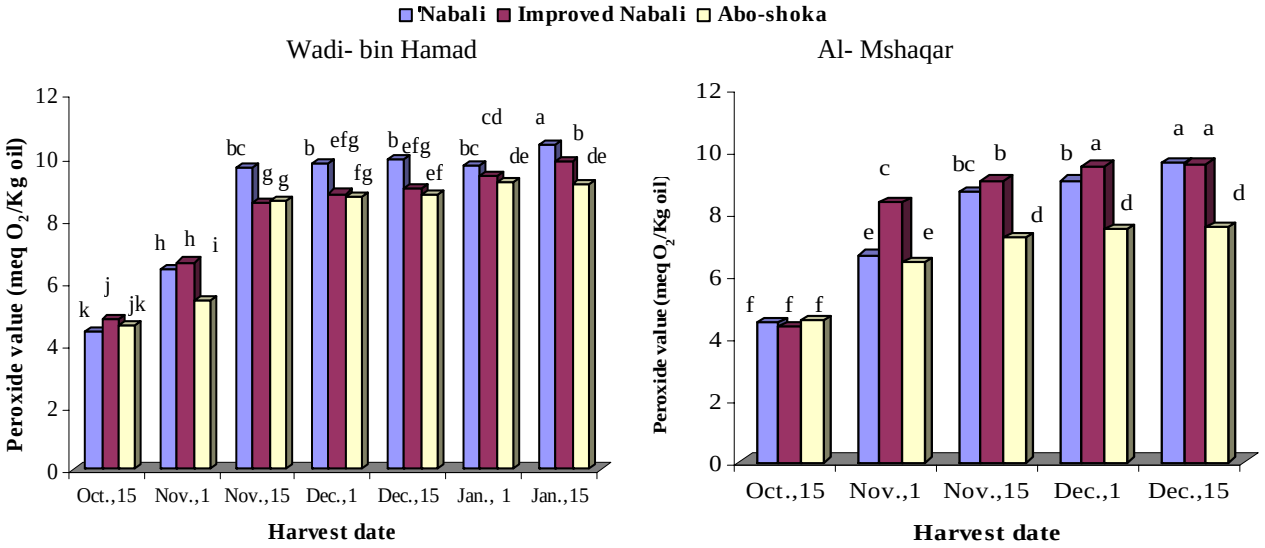


Fig. 2. Olive oil peroxide value of three cultivars at different harvesting dates at Al- Mshaqar and Wadi-bin Hamad orchards



significantly from 4.80 on October 15, 2006 to 9.83 on January 15, 2007. The lowest peroxide value obtained on October 15, 2006. Regarding Abo-shoka, the same trend was observed. No significant differences were obtained between November 15, December 01 and December 15, 2006. Similar result was obtained by Freihat *et al.* (2008). The behavior of peroxide value to increase during olive ripening could be explained with an increase of the activity of the enzyme lipoxygenase (Rotondi & Lercker, 1999).

Olive oil percentage (fresh weight basis). Percentage of oil (fresh weight basis) significantly influenced by the three cultivars. The highest oil content was observed in cv Nabali and the lowest oil content was in cv Abo-shoka (Fig. 3). The oil accumulation increased until the onset of epicarp blackening, when oil no longer accumulated into the fruit (Inglese, 1999). The data indicates that the oil content (fresh weight basis) at both locations increased from October 15, 2006 to December 15, 2006. The final oil content in the fruit is dependent on the interaction between the growing conditions and the genetic potential of the variety as well as, to the amount of mesocarp available for oil biosynthesis (Lavee & Wodner, 2004). This result agreed with the previous results obtained for other olive cultivars by Shibasaki (2005), Al-Rousan (2004) and Ramos *et al.* (2008).

Olive oil percentage (dry weight basis). Significant differences among cultivars in oil percentage (dry weight basis) were observed at the same harvesting date. At both locations, the highest percentage oil observed for Nabali, while the lowest oil was in Abo-shoka (Fig. 4). Regardless

Fig. 3. Olive oil percentage (fresh weight basis) of three cultivars at different harvesting dates at Al-Mshaqar and Wadi- bin Hamad orchards

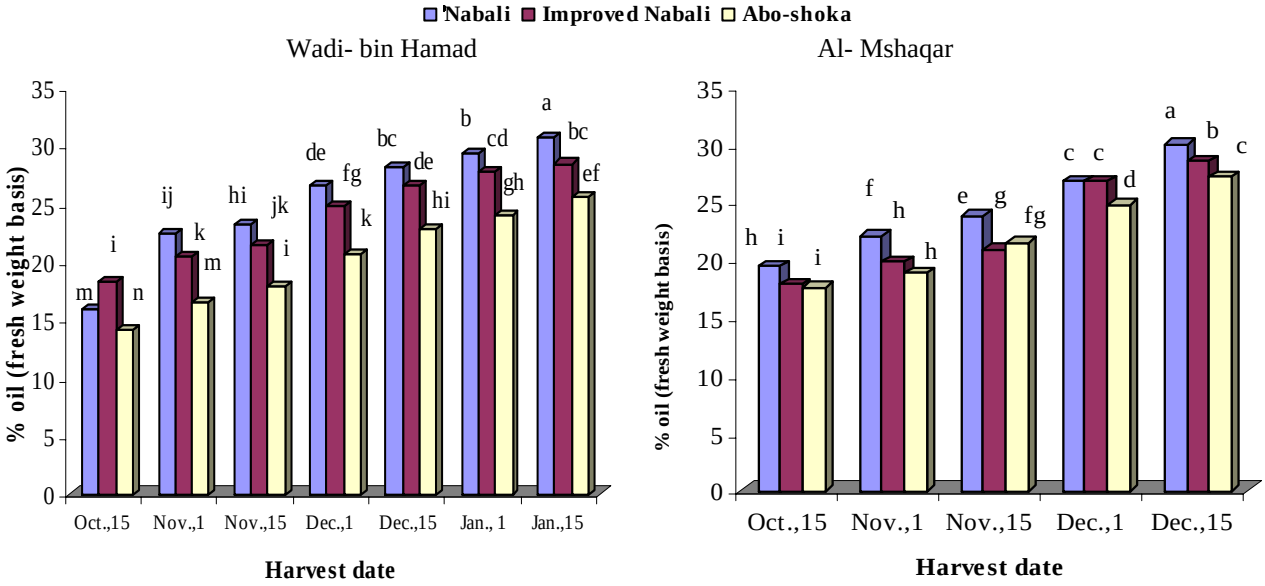
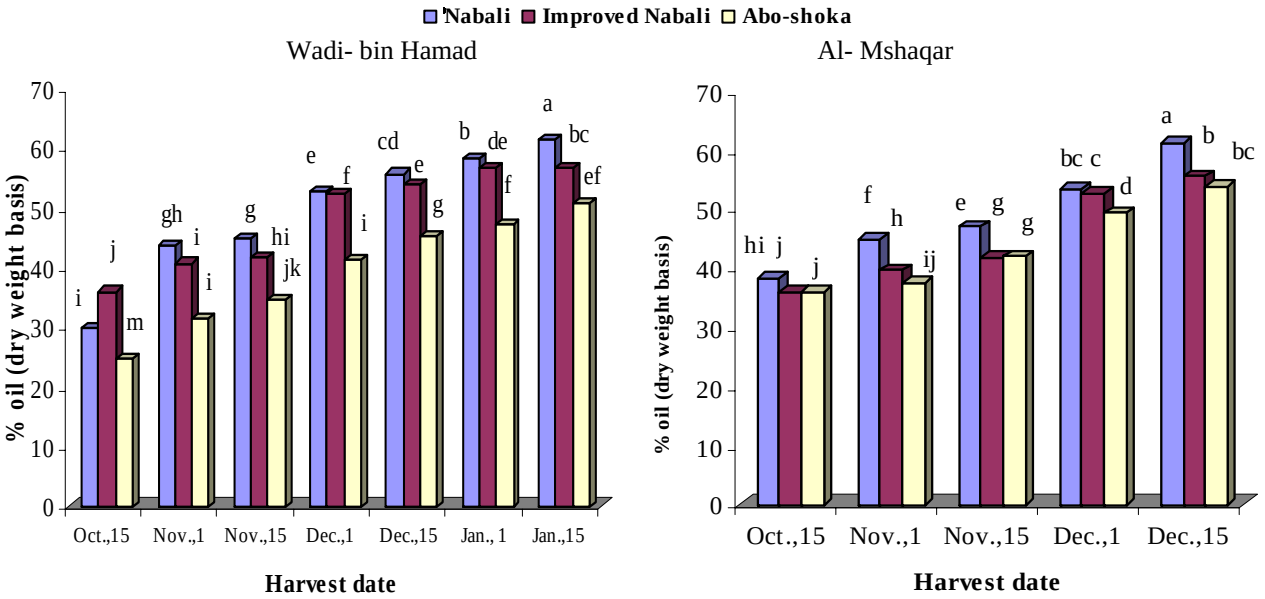


Fig. 4. Olive oil percentage (dry weight basis) of three cultivars at different harvesting dates at Al-Mshaqar and Wadi-bin Hamad orchards



the cultivar, the result shows that there was significant increase in oil percentage as ripening progressed. The gain in the fruit oil content during maturation at Wadi-bin Hamad was slightly slower comparing with the oil at Al-Mshaqar. These results are in consistency with those reported by Inglese (1999), Fimiani *et al.* (1999), Tous *et al.* (1996) and Al-Rousan. (2004).

Chlorophyll content. Chlorophyll has been shown to have a pro-oxidant effect on oil stability under light conditions (Psomiadou & Tsimidou, 2001). Data presented in Fig. 5 showed that there were significant differences among the three cultivars at Al-Mshaqar location. The highest chlorophyll content observed for Abo-shoka, while the lowest content obtained for Nabali. However, at Wadi-bin Hamad location, the highest content observed for Abo-shoka, while Improved Nabali had the lowest chlorophyll content. At both locations, significant reduction noticed for total chlorophyll content as ripening progressed. This result could be explained to the decline in chlorophyll pigment as ripening progressed, which allow for the other pigments like anthocyanins, carotene and carotenoids to dominate. These results agreed with the previous results by Grati *et al.* (1999)

Fig. 5. Olive oil chlorophyll content of three cultivars at different harvesting dates at Al-Mshaqar and Wadi-bin Hamad orchards

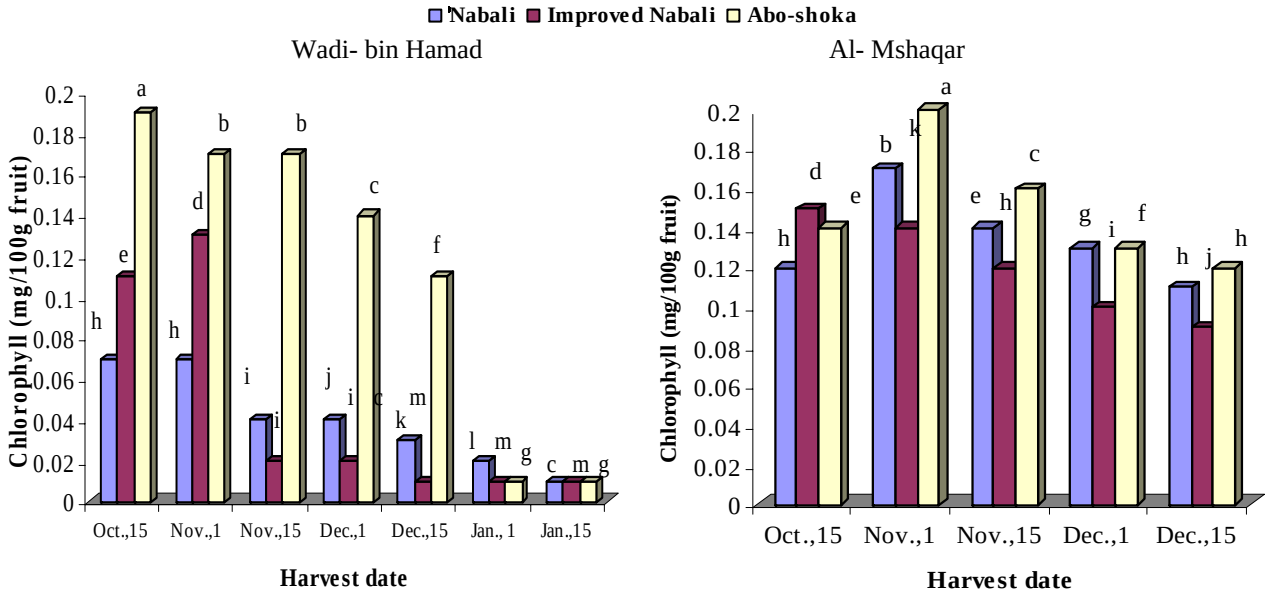
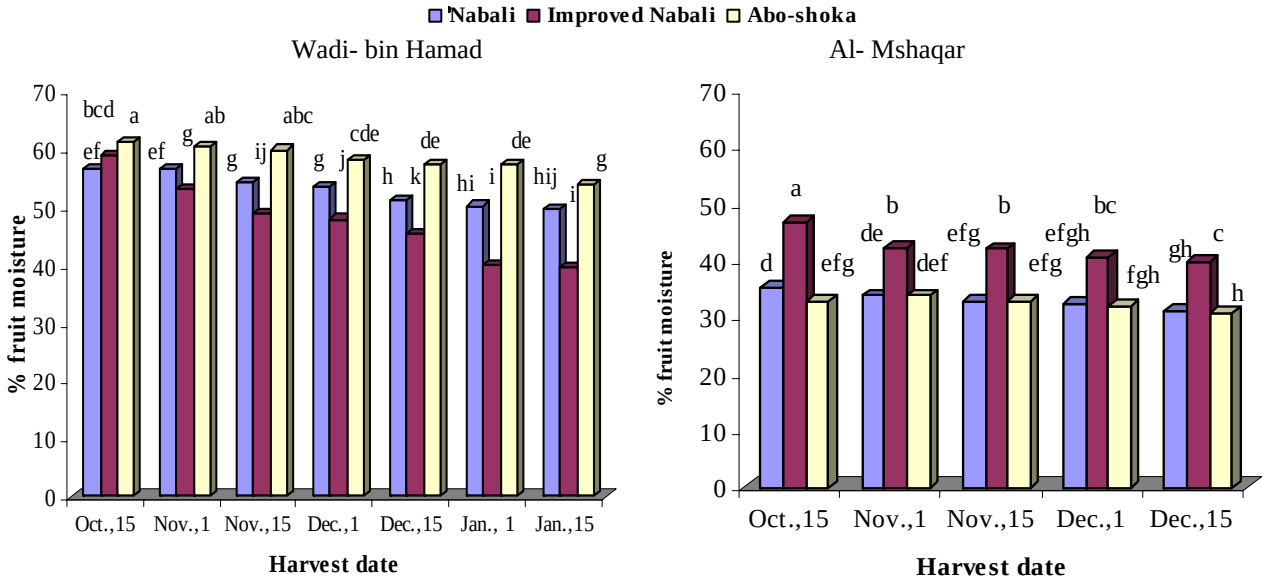


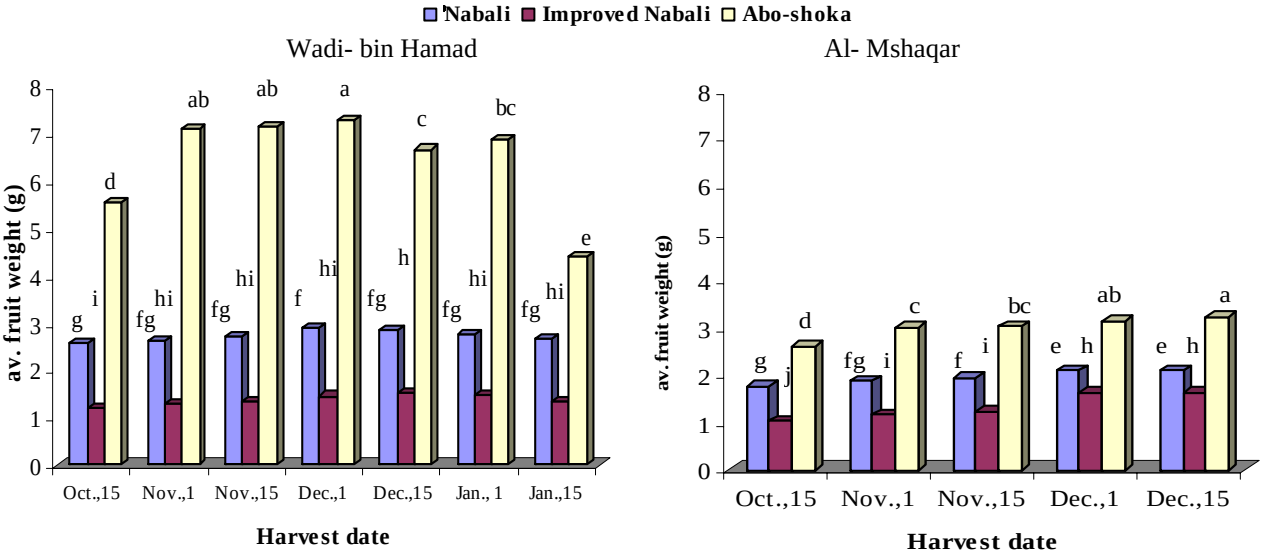
Fig. 6. Percentage of fruit moisture of three olive cultivars at different harvesting dates at Al-Mshaqar and Wadi-bin Hamad orchards



and Ayton *et al.* (2007). According to Criado *et al.* (2007), the destruction of the chlorophyll fraction was greater than of the yellow pigments during the olive oil extraction process.

Moisture percentage. At the Al-Mshaqar location, the results reported in Fig. 6 show insignificant differences in fruit moisture content between cv Nabali and cv Abo-shoka, while cv Improved Nabali cv had significantly higher fruit moisture. At the Wadi bin-Hamad location, significant differences were observed among the three cultivars. Abo-shoka had significantly higher fruit moisture than the other cultivars, while Improved Nabali had the lowest. The data shown in Fig. 5 indicates that fruit moisture significantly decreased as ripening progressed for the three cultivars at both locations. During ripening, fruits lose water easily because of cracks on the protective wax around the epicarp of lenticels or other epidermal opening (Tombesi *et al.*, 1994). These results confirm the findings of Hartman (1991), Al-Rousan (2004) and Mailer *et al.* (2007). According to Cimato (1990), the reduction in moisture of fruit moisture along harvesting date could be explained to the metabolism process occur inside the drupes.

Fig. 7. Average fruit weight of three olive cultivars at different harvesting dates at Al- Mshaqar and Wadi- bin Hamad orchards



Average fresh fruit weight. The average fruit weight was significantly influenced by the cultivar (Fig. 7). At both locations, the highest average fruit weight observed for Abo-shoka, while the lowest was for Improved Nabali. These results could be explained by the negative relationship between number of fruit and fruit weight since it was concluded that Improved Nabali had the highest number of fruits (data not shown). The average fruit weight significantly increased as ripening progressed. Similar results were obtained by Famiani *et al.* (1999), Hartman (1991) and Mailer *et al.* (2007).

CONCLUSION

Olive oil acidity, peroxide value and oil percentage of all cultivars increased as ripening progressed at Wadi-bin Hamad and Al-Mshaqar. However, chlorophyll content and moisture percentage decreased with ripening. Considerable differences were observed among the three cultivars at both locations. It could be concluded from the results of this investigation that January 15, 2007 and December 01, 2006 are the optimum harvesting dates at both locations for obtaining the best olive oil quality and quantity under the conditions of this research. However, the optimum harvesting date may be changed if the extraction method of olive oil varied.

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