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# Determination of Essential Fatty Acids in Popular Olive Cultivars Grown in Saudi Arabia

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**Abstract:** Presently, the use of olive oil is increasing in many conventional food items owing to its health benefits due to the presence of essential fatty acid. The main objective of this study was to determine the concentration of some of these fatty acids such as Omega-3 and Omega-6 in locally produced olive oil in Saudi Arabia. Olive oil samples used for analysis were collected from NADEC and Al-Jouf farms located in Al-Jouf Region (Northern of Saudi Arabia) and imported Palestinian olive oil. Linolenic C18:3 (Omega-3) was significantly high in PICUAL H78 cultivar (2.13%) whereas C18:2 (Omega-6) was highest (21.81%) in K-18 cultivar at Al-Jouf Farm. Similarly, C18:3 (Omega-3) was significantly high in KORONIEKE cultivar (1.90%) where C18:2 (Omega-6) content was 18.15% in ARBEQUINA cultivar of NADEC Farm. Besides, the C18:3 (Omega-3) was significantly higher in Palestinian olive oil (2.11%) compared to oil produced in Al-Jouf and NADEC Companies. The C18:2 (Omega-6) was significantly high in olive oil (17.25%) produced by NADEC Company. However, the differences in fatty acids content among the different cultivars could be attributed to genetic, environmental and location variation. Based on these results, olive oil from cultivar PICUAL H78 of Al-Jouf and KORONEIKE of NADEC could be recommended for consumption due to high level of C 18:3 (Omega 3) for its health benefits compared to the other tested samples. The analysis of composite olive oil samples for fatty acid showed that the contents of C18:3 (Omega 3) fatty acid were significantly higher in the Palestinian olive oil (2.11%) than the oil produced at Al-Jouf (1.74%) and NADEC (1.64%) locations. In conclusion, olive cultivars such as PICUAL H78 of (Al-Jouf), ARBOSANA and KORONEIKE of (NADEC) showed potential for producing olive oil with high Omega 3 content under local environmental conditions.

**Key words:** Fatty acids, omega-3, omega-6, cultivars, NADEC, al-Jouf, climatic conditions Saudi Arabia

## INTRODUCTION

Presently, interest is on the rise in the consumption of virgin olive oil (VOO) due to its beneficial effects on human health. Primarily, these effects are attributed to high level of Monounsaturated Fatty Acids (MUFA) in VOO which are more resistant to lipid peroxidation than Polyunsaturated Fatty Acids (PUFA) (Kris-Etherton *et al*., 2002). Olive oil production is influenced by climatic, genetic and agronomic factors and by their interactions. Climatic factors such as temperature and precipitation affect olive trees physiological behavior and consequently the chemical characteristics of its oil (Aparicio *et al*., 1994; Pannelli *et al*., 1994; Moussa and Gerasopoulos, 1996; Ryan *et al*., 1998). Ferrara (2000) stated that olive oil is extensively consumed due to its nutritional value and organoleptic characteristics. The extra virgin olive oil is the principal source of fat in the Mediterranean diet with important nutraceutic effects due to high contents of oleic acid, a monounsaturated fatty acid that controls cholesterol level. Adequate content of linoleic and linolenic acids which represents the main essential fatty acids that lower the risk of coronary heart diseases and cancers (Galli and Visioli, 1999). The olive tree (*Olea europaea* L.) is one of the most important crops in Mediterranean countries, especially Spain, Italy and Greece. Use of Virgin Olive Oil (VOO) without refining showed interesting nutritional and sensorial properties. Its fatty acid composition, monounsaturated and its natural antioxidants provide advantages for health (De Martinez and Manas, 2001; Visioli and Galli, 1994, 1998). The monounsaturated fatty acids are highly important because of their nutritional implication and effect on oxidative stability of oils (Aguilera *et al*., 2000). Moreover, Grati Kamoun *et al*. (2002) studied the pomological and chemical characterization of some

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cultivars (Chemlali name) and found that different cultivars are genetically distinct according to their geographical origin.

However, Turhan *et al*. (2010) reported that oil concentration and quality in sunflower (*Helianthus annuus* L.) were affected by environmental conditions such as temperature, precipitation, relative humidity and cloudiness. They reported that oil content and fatty acid composition significantly changed by ecological and topographic conditions. Oil content in seeds varied 39.82-44.30% depending on location. Percentages of major fatty acids such as linoleic, oleic, palmitic and stearic acid were also significantly affected by growth location. As a result, environment or growth conditions significantly affect sunflower oil content and fatty acid composition. Leon *et al*. (2004) evaluated some olive cultivars 'Arbequina', 'Frantoio' and 'Picual' for fatty acid composition over two consecutive years. Gas chromatography was used for analyzing the main fatty acids of olive oil: Palmitic (C16:0), palmitoleic (C16:1), stearic (C18:0), oleic (C18:1) and linoleic (C18:2). Wide ranges of variation were obtained for all the fatty acids; as large as or even larger than the ranges reported for the evaluation of olive cultivar collections. Previously, some investigators reviewed several factors influencing the aromatic quality of virgin olive oil such as biogenesis, composition of volatiles, relationships with sensory notes, possible influence of agronomic and processing factors and oil oxidation (Kalua *et al*., 2007; Angrosa *et al*., 2004). All these findings showed that volatiles content are mainly C6-and C5-skeleton compounds from the lipoxygenase pathway were strongly influenced by the genetic origin (cultivar). In a previous study, Tura *et al*. (2007) observed that the antioxidant profile was influenced by the cultivar and the site of cultivation.

Allalout *et al*. (2009) evaluated minor components (phenolic compounds, α-tocopherols and pigments), fatty acid contents and oxidative stability of virgin olive oil of Spanish cultivars: Arbequina, Arbequina I-18 and Arbosana and Greek cultivar: Koroneiki grown in Northern Tunisia under irrigated high-density plantation system. The phenolic compounds, α-tocopherols, total phenols and o-diphenols showed significant correlations with oxidative stability. Aguilera *et al*. (2005) carried out study on the characterisation of virgin olive oils from the main Italian cultivars, 'Frantoio' and 'Leccino', grown in two different locations in Andalusia: Mengibar (Jaen) and Cabra (Cordoba), with important differences in altitude. There were significant differences between cultivars grown in the different environments, Cabra close to the hills and Mengibar in the open at 280 m height. At higher altitude, oils contained greater oleic acid and higher stability, while in the open the oils had higher tocopherol and linoleic acid contents. Sensory evaluation showed significant differences between the oils from each cultivar and location. In general, oils from Andalusia had higher levels of natural antioxidants, greater oxidative stability and more marked sensorial characters. The amounts of all these chemical components are influenced to a large extent by the cultivar, soil, climate, irrigation, degree of ripeness and processing methods (Morello *et al*., 2004). Stefanoudaki *et al*. (1997) analyzed one hundred and twenty authentic olive oil samples of the two major Cretan olive cultivars, Koroneiki and Mastoidis at different maturity stages obtained from different producing areas. Within each variety the oils were grouped quite clearly according to their geographic origin. However, samples originated from neighbouring locations did not show any marked differences in geographic morphology. Samples from locations with some extremes in the climatic conditions, presented some discrepancies in classification. Ollivier *et al*. (2006) considered all possible isomers to determine fatty acid compositions. The utilization of propionitrile, instead of the mixture of acetone/acetonitrile lead to a better separation of the triacylglycerols especially of the crucial pairs LOO+PLnP/PoOO, PLO+SLL/PoOP, SOL/POO (Aranda *et al*., 2004). The main triglycerides (TG) found in the Cornicabra virgin olive oil variety samples analyzed were OOO, SOL +POO, OLO+LnPP and OLA+SOO, as expected from the high oleic acid and low linoleic and linolenic acid contents observed for both, the total and sn-2 position Fatty Acids (FA); these accounted for more than 85% of the total HPLC chromatogram peak area.

Many researchers reported that the main fatty acids composition of olive oil are between the myristic (14 carbon atoms) and lignoceric (24 carbon atoms) while the most prominent are the mon-ounsaturated oleic, palmitoleic and the polyunsaturated linoleic and linolenic. The approved limits for some of these have been published by European Union (ECR, 2001) and International Olive Oil Council and previously discussed by Conte *et al*. (2000). They further stated that fatty acids compositions differ from sample to sample and influenced by the olive variety, production zone, climate and stage of maturity of the drupes when they are collected. Salimon and Farhan (2012) stated that Saudi extra virgin olive oil (SEVOO) is considered to be the best olive oil for its organoleptic characteristics, oxidative stability and chemical composition. It is practically the only vegetable oil that can be consumed directly in its raw state and contains important nutritional elements such as vitamins and antioxidants. The SEVOO recorded an acidity value of

1.4%, iodine value of 88.4, saponification value of 192.7 and unsaponifiable matter of 14%. The SEVOO contains 62.8% oleic acid which is monounsaturated fatty acid and 12.4% of linoleic acid, a polyunsaturated fatty acid. The main saturated fatty acid is palmitic acid (16.6%). However, the oil extracts exhibited remarkable physicochemical properties and could be useful as edible oils and for industrial applications. Whereas, Abdullah (2010) compared both the physical and chemical characteristics of the Saudi Extra Virgin Olive Oil (SEVOO) with the Saudi Olive Oil (SOO) and found identical results with respect to all parameters. Gutierrez *et al.* (1999) reported that SEVOO composition and intrinsic quality could be influenced by several factors. They further stated that, cultivar, environment and agronomic practices affect the fruit physiology, whereas processing and storage conditions alter oil composition.

As shown by the literature review, very little work was done regarding the composition of some important fatty acids of Saudi Olive Oil (SOO) produced in different locations and designated for human consumption. Therefore, the main objective of this study was to determine the fatty acids profile of different types of Saudi olive oil and evaluate it for human consumption and industrial purposes.

## MATERIALS AND METHODS

**Samples collection:** Olive fruit samples were collected from different cultivars during the 2012 cropping season. The study was carried using 8 samples of olive fruits obtained from two olive growers (NADEC and Al-Jouf Agriculture Companies) in Al-Jouf region, Northern of Saudi Arabia. One liter of olive oil sample was collected from each cultivar grown at NADEC and Al-Jouf Agriculture companies as well as one liter of imported Palestine olive oil from local market. The study was carried on fresh olives from olive cultivars being grown at NADEC and Al-Jouf Companies under optimum plant growth conditions. The olive cultivars and their geographical origin are presented in Table 1.

**Standards for fatty acid profiles:** The 37 component FAME Mix from Supelco, Sigma-Aldrich, USA was used to identify different fatty acids of pure and adulterated samples.

**Preparation of olive fruit samples:** Eight samples of olive fruits were separated and cleaned by removing the stems, leaves, twigs and other debris. Then, the olive fruit was washed with water to remove pesticides, dirt, etc., then dried followed by crushing by mortar and pestle into a paste. The paste was mixed for 20-45 min which allowed small oil droplets to combine into bigger ones. The paste was transferred into cheese cloth and pressed by weight overnight to collect oils at room temperature. Then the juices were centrifuged and oil extracted elicit kept in freezer for analysis. Approximate composition of different fruits is presented in Table 2.

Table 1: Olive fruits were collected from olive cultivars grown at NADEC and Al-Jouf farms in the northern region of Saudi Arabia

| Source of olive fruit varieties | |
|---|---|
| NADEC | Al-Jouf |
| Koronieke | Kaisy |
| Picual | Sorany |
| Arbequina | K-18 |
| Arbosana | Picual h78 |

Table 2: Approximate composition of olive fruits (%)

| Sample | Protein | Fiber | Crude fat | Ash | Moisture |
|---|---|---|---|---|---|
| koronieke | 3.2 | 34 | 21 | 1.38 | 59 |
| Picual | 3.9 | 30 | 19 | 1.92 | 56 |
| Arbequina | 3.3 | 35 | 20 | 2.07 | 59 |
| Arbosana | 3.5 | 34 | 22 | 2.06 | 58 |
| Kaisy | 3.1 | 36 | 15 | 1.95 | 59 |
| Sorany | 3.3 | 31 | 24 | 3.50 | 57 |
| K-18 | 3.6 | 32 | 11.1 | 5.22 | 54 |
| Picual h78 | 3.2 | 33 | 22 | 1.96 | 65 |

**Derivatization of fatty acid to FAME:** The analytical methods for determining the fatty acid compositions were performed by transesterification of olive oils to their constituent fatty acid methyl esters (FAME) according to the method of Timms (1978) and Bakar *et al.* (2008). The extracted olive oil sample was diluted in 4 mL of n-hexane followed by the addition of 50 μL of sodium methoxide in a test tube with a screw cap. The mixture was shaken by vortex for 5 sec and left for 30-60 min until the separation of two phases. The top layer, a FAME, was filtered through a 0.45 μ syringe filter, centrifuged for 4 min at 12,000 rpm and the supernatant was transferred into 2 mL vial before proceeding to the Gas Chromatography (GC) analysis.

**Determination of FAME by GC:** Analysis of FAME was performed using Agilent 7890A (Agilent Technologies, Santa Clara, California) by injecting 1 μL supernatant layer containing the methyl esters into the GC analysis (equipped with a flame-ionization detector and a polar capillary column (HP88-Agilent Technologies, USA), 100 m, 0.25 mm and 0.25 μm film, internal diameter and film thickness, respectively, to obtain individual peaks of FAME). The GC conditions included the temperature of the column at 90°C, programmed to increase to 220°C at 15°C $min^{-1}$ (for 5 min), 2°C $min^{-1}$ and 15°C $min^{-1}$ (for 1 min). The temperature of the injector and detector was maintained at 240°C. The total run time was 40 min.

The mobile phase was helium with a column flow rate of 1.9 mL $min^{-1}$. In the detector, flow rate of helium gas was 30 mL $min^{-1}$. The FAME peaks were identified by comparing their retention time with certified reference standards of FAME (Supelco, Sigma-Aldrich, USA). Relative percentage of fatty acid was calculated from the peak area of the fatty acid species to the total peak area of all the fatty acids in the oil samples.

**Data analysis:** Experimental data were analyzed by following various statistical techniques (ANOVA, regression analysis) by following different methods given in SAS (2001).

## RESULTS AND DISCUSSION

### Results

**Linolenic C18:3 (Omega 3) fatty acid:** Means of fatty acid contents (%) of Linolenic C18:3 (Omega 3) were 1.60, 1.45, 2.13 and 1.70 for Sorany, K-18, PICUAL H78 and Kaisy cultivars, respectively (Table 3). The contents of this fatty acid were significantly higher for PICUAL H 78 cultivar as compared to other cultivars from Al-Jouf agriculture farms. However, other cultivars exhibited no significant difference between them. The order of increasing trend in the fatty acid contents was PICUAL H78>Kaisy>Sorany>K-18. Based on these results, olive oil from cultivar PICUAL H78 seems better for human consumption than other cultivars for its high Linolenic C 18:3 (Omega 3) fatty acid content.

Figures in a column followed by the same letters are not significantly different at 5% level of significance.

Mean fatty acid contents (%) Linolenic C18:3 (Omega 3) were 1.87, 1.53, 1.33 and 1.90 in Arbosana, Picual, Arbequina and Koronieke cultivar, respectively (Table 4). Koronieke displayed significantly higher Linolenic C18:3 (Omega 3) fatty acid followed by in descending order by Arobosana, Picual and Arbequina cultivars. There was no significant difference in the fatty acid contents Koronieke and Arbosana cultivars as well as between Picual and Arbequina cultivars. This could mean that Koroneike cultivar is the best among those grown at NADIC farm due to its high Omega 3 content. Furthermore, the variation in the fatty acid contents among different cultivars grown at the same farm could be attributed to the genetic behavior of individual cultivar.

Figure in a column followed by the same letters are not significantly different at 5% level of significance.

Overall analysis of composite olive oil sample for fatty acid showed that the contents of fatty acid Linolenic C18:3 (Omega 3) were significantly higher in the Palestinian olive oil (2.11%) as compared to that obtained from cultivars grown at Al-Jouf (1.74%) and NADEC (1.64%) agricultural farms (Table 5). This difference in fatty acid contents could be due to different climatic conditions and management practices followed at different locations.

Table 3: Fatty acid contents (%) in olive cultivars of Al-Jouf company

| Cultivars | Linolenic C18:3 (Omega-3) | Linoleic C18:2 (Omega-6) |
|---|---|---|
| Sorany | 1.60[b] | 16.96[b] |
| K-18 | 1.45[b] | 21.81[a] |
| Picual h78 | 2.13[a] | 13.68[b] |
| Kaisy | 1.70[b] | 16.85[b] |
| Mean | 1.72 | 17.33 |
| SD* | 0.292 | 3.354 |

In a column followed by the same letters are not significantly different at 5% level of significance

Table 4: Fatty acid contents (%) in olive cultivars of NADEC company

| Cultivars | Linolenic C18:3 (Omega-3) | Linoleic C18:2 (Omega-6) |
|---|---|---|
| Arbosana | 1.87[a] | 16.36[a] |
| Picual | 1.53[b] | 13.61[b] |
| Arbequina | 1.33[b] | 18.15[a] |
| Koronieke | 1.90[a] | 13.63[b] |
| Mean | 1.66 | 15.44 |
| SD* | 0.275 | 2.222 |

In a column followed by the same letters are not significantly different at 5% level of significance

Table 5: Fatty acid contents (%) in composite sample of olive oil produced by different companies

| Name of oil producing company | Linolenic C18:3 (Omega-3) | Linolenic C18:2 (Omega-6) |
|---|---|---|
| Nadec | 1.64[b] | 17.25[a] |
| Al-Jouf | 1.74[b] | 14.25[b] |
| Palestinian oil | 2.11[a] | 14.50[b] |
| Mean | 1.83[b] | 15.33 |
| SD* | 0.247 | 1.664 |

In a column followed by the same letters are not significantly different at 5% level of significance

**Linoleic C18:2 (Omega-6) fatty acid:** The mean Linoleic C18:2 (Omega-6) content for Sorany, K-18, Picual H78 and Kaisy cultivar, were 16.96, 21.82, 13.68 and 16.85%, respectively (Table 3). The contents of this fatty acid were significantly higher in K-18 as compared to other cultivars grown at Al-Jouf farm location. Omega 6 of K-18>Sorany >Kaisy>PICUAL H78. However, the difference in between other cultivars was not significant (Table 3). The high Omega 6 content of K-18 cultivar makes it a better choice for human consumption compared to other cultivars.

The mean fatty acid contents (%) of Linoleic C18:2 (Omega-6) were 16.36, 13.61, 18.15 and 13.63 in Arbosana, Picual, Arbequina and Koronieke cultivar, respectively at NADEC Company Farm (Table 4). Linoleic C18:2 (Omega-6) contents were significantly higher for Arbequina followed by Arobosana, Koronieke and Picual cultivars. Although, there was a decreasing trend in the contents of this fatty acid, the difference in the fatty acid contents was not significant among Arobosana, Koronieke and Picual cultivars. Therefore, owing to high contents of this fatty acid, cultivar Arbequina is a better choice than other cultivars grown at NADEC farm.

Furthermore, the difference in the fatty acid contents among different cultivars grown at the same farm could be attributed to the genetic makeup of the individual cultivar. Overall, fatty acid contents from composite olive oil samples showed that the contents of fatty acid Linoleic C18:2 (Omega-6) is significantly higher in olive oil produced at NADEC (17.25%) as compared to Palestinian oil (14.50%) and Al-Jouf farm (14.25%) (Table 5). Also, there is no significant difference in the fatty acid contents between the composite sample of oils produced in Al-Jouf area and Palestine. The difference in the fatty acid contents could be due to the differences in the environment and the management practices adopted for the cultivation of different cultivars at different locations.

## DISCUSSION

**Cultivar effect:** The study results showed that the contents of Linolenic C18:3 (Omega-3) fatty acid ranged between 1.45-2.13% in different cultivars cultivated by Al-Jouf Company. The fatty acid contents were significantly high in the oil of Picual H78 than other cultivars. Similarly, contents of Linoleic C18:2 (Omega-6) fatty acid ranged between 13.68-21.81% in different cultivars at Al-Jouf Company with highest value of 21.81% in K-18 cultivar. The differential contents among the different cultivars could be attributed to genetic variability of individual cultivar grown at the same farm. Similarly, fatty acid contents of Linolenic C18:3 (Omega-3) ranged between 1.33-1.90% in different cultivars grown at NADEC Company. The fatty acid contents were significantly high in the oil of Koronieke (1.90%) than other cultivars. Also, contents of Linoleic C18:2 (Omega-6) fatty acid ranged between 13.61-18.15% in different cultivars at NADEC Company with highest value of 18.15% in Arbequina cultivar. The differential contents among the different cultivars could be attributed to genetic variability of individual cultivar grown at the same farm. The present study results agree with those of Dhifi *et al.* (2005) who found that the contents of palmitic, oleic and linoleic acids and the oxidative stability presented significant differences between cultivars, locations and their interactions. In the same way, Youssef *et al.* (2011a) reported that most of the quality indices and fatty acid composition showed significant variations among different olive varieties. These results suggest that the genetic factor (cultivar) influences volatiles formation. Youssef *et al.* (2011b) observed significant differences in the proportion of volatiles from oils of different geographical locations. The results suggest that, besides genetic factors, environmental conditions influence volatile formation. Also, Dabbou *et al.* (2010) observed the quality indices and fatty acid composition of Tunisia olive oil showed significant variations among cultivars. The Koroneiki, Coratina and Chemlali Zarzis cultivars had highest values of oleic acid (62.7, 76.8, 75.8 and 73.9%, respectively). In another study, Poiana and Mincione (2004) showed the increasing trend in oleic acid content in Cassanese, Itrana, Coratina, Sinopolese, Pendolino and Leccino. Palmitic and linolenic acid showed a decrease in all the observed cultivar. Some cultivars in early ripe stage showed higher linolenic acid content than the limit established legally.

**Environmental factors:** The contents of Linolenic C18:3 (Omega-3) fatty acid ranged between 1.64-2.11% in different cultivars grown under different agronomic conditions at different locations in the Kingdom and elsewhere (Palestine). The mean contents of this fatty acid were significantly high in Palestinian olive oil followed in descending order by Al-Jouf and NADEC Company, respectively. The fatty acid contents of Linoleic C18:2 (Omega-6) ranged between 14.25-17.25% in olive oil produced at different places (NADEC, Al-Jouf and Palestine) under different plant growth conditions. The fatty acid contents of Omega-6 were significantly high in olive oil produced at NADEC Company. However, the different in the fatty acid contents was not significant between olive oil produced by Al-Jouf Company and imported from Palestine. This differential in fatty acid might be due to different environmental conditions at both locations.

Similar results were reported by Guerfel *et al.* (2009) on the characterization of virgin olive oil samples from fruits of the main Tunisian olive cultivars Chemlali and Chétoui, grown in three different Tunisian locations, Zaghouan (North), Sousse (Center) and Sfax (South). They reported higher mean of total phenol content (1004 and 330 mg $kg^{-1}$, respectively). Olive oil samples obtained from both cultivars showed different phenolic profiles and high contents of 3,4-DHPEA-EDA in olive trees cultivated in Zaghouan. Both of the olive cultivars showed different response to environmental conditions. Also, Di Vaio *et al.* (2012) reported that environmental changes influenced the content of Ortice oil fatty acids and polyphenols, while the flavor profile remained fairly stable in both environments. Recently, Issaoui *et al.* 2010 reported significant differences between the oils of two cultivares (Chemlali and Chétoui) grown in the different environments. At higher altitude, oils showed high contents of oleic acid, phenols and higher storage stability. While under open areas, oils contained high amount of saturated and linoleic acid content. Also, aroma profiles were influenced by climatic conditions; hence, oils from the South had the highest level of (E)-2-hexenal and 1-hexanol, whereas varieties from the North were higher in (E)-3-hexenyl acetate and hexyl acetate.

## CONCLUSION

The contents of Linolenic C18:3 (Omega-3) fatty acid was significantly high in Picual H78 (2.13%) than other cultivars, while the contents of Linoleic C18:2 (Omega-6) fatty acid were highest (21.81%) in K-18 cultivar at Al-Jouf Farm. Similarly, fatty acid contents of Linolenic C18:3 (Omega-3) were significantly high in Koronieke (1.90%) oil than other cultivars, while the contents of Linoleic C18:2 (Omega-6) fatty acid were highest (18.15%) in Arbequina cultivar at NADEC Farm. The differential contents among the different cultivars could be attributed to genetic variability of individual cultivar grown at the same farm.

The contents of Linolenic C18:3 (Omega-3) fatty acid were significantly high in Palestine olive oil (2.11%) followed in descending order by Al-Jouf and NADEC Company. The contents of Linoleic C18:2 (Omega-6) fatty acid were significantly high in olive oil (17.25%) produced at NADEC Company. This difference could be due to different environmental conditions at both the places. Based on the results, olive oil from cultivar Picual H78 at Al-Jouf Company is a better choice for consumption than other cultivars for its high contents of Linolenic C 18:3 (Omega 3) fatty acid which is beneficial for health. Due to high contents of this fatty acid, the cultivar Koroneike is better than other cultivars grown at NADEC farm.

The analysis of composite olive oil sample for fatty acid showed that the contents of Linolenic C18:3 (Omega 3) fatty acid were significantly higher in Palestinian olive oil (2.11%) as compared to that obtained from cultivars grown at Al-Jouf (1.74%) and NADEC (1.64%) agricultural farms. Also, olive oil extracted from K-18 seems to be better for consumption than other cultivars as it contains high contents of Linoleic C 18:2 (Omega-6) fatty acid is beneficial for health. Overall fatty acid contents from composite olive oil samples showed that the contents of fatty acid Linoleic C18:2 Omega-6 is significantly higher in olive oil produced at NADEC (17.25%) as compared to olive oil from Palestinian (14.50%) and Al-Jouf farm (14.25%). In conclusion, the olive cultivars such as PICUAL H78 of (Al-Jouf), ARBOSANA and KORONEIKE of (NADEC) showed potential for producing olive oil with high Omega 3 content under local environmental conditions.

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