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Evaluation of Olive Oil Produced From Some Varieties Growing under Siwa Oasis Condition

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ABSTRACT

The purpose of this study was to evaluate the quality indices and sensory evaluation of olive oil samples extracted from three varieties olive (*Olea europaea* L.), Frangivento (FOOS), Maraqi (MOOS) and Coratina (COOS) growing in Siwa Oasis, and two varieties olive Maraqi (MOOD) and Coratina (COOD) growing in Desert Rood to identify and classify the oil. The samples which were studied collected from Siwa Oasis and Desert Rood region were examined for physical and chemical properties (acidity, peroxide value, ultraviolet spectrophotometric analysis K232 and K270, fatty acids composition and total phenol content. Olive oil was analyzed for fatty acids commonly present in olive oils which are Palmitic, Palmitoleic, Stearic, Oleic, Linoleic, Linolenic, and Arachidic. Oleic acid was found in high percentage ranged from (71.63% in FOOS cultivar up to 76.00% in MOOD), followed by Palmitic, Linoleic, Stearic, Palmitoleic, and Linolenic. Arachidic acid was detected in all olive oil samples but in low percentage. Oxidative stability by Rancimat method and phenolic compositions by HPLC, were analyzed for each oil samples. Small differences were detected depending on the growing area. In general the main phenolic compound (Oleuropein, Hydroxytyrosol, *p*-Coumaric and Tyrosol), were present in higher levels in the oil obtained from olive oils under this studied. Big difference was observed for total polyphenols content within the cultivars, total polyphenols of MOOD cultivar olive oil was the highest (211.05 mg/ kg oil) while the lowest (139.31 mg/kg oil) was in the COOS cultivar. Resistance to oxidation was assessed by Rancimat method and showed a good correlation with the amount of total phenols. Also, results of the quality indices (free acidity, peroxide value, k_{232}, k_{270} and sensory analysis) revealed that, all the analyzed oils were classified into extra virgin category according to IOC 2011 (Trade standard for olive oil). Also, results showed that small differences of quality indices between olive oil samples extracted from five varieties under investigation.

Keywords: Olive oil, Olive cultivars, Phenolic compounds, Oxidative stability.

1. Introduction

The olive oil is one of the oldest oils mainly produced in countries around the Mediterranean Sea. Its consumption is increasing throughout the world due to the growing interest in the Mediterranean diet, of which olive oil is one of the main ingredients and which is often strongly correlated with the reduction of cardiovascular diseases and certain forms of cancer (Artajo *et al.,* 2006).

In addition to the lipid fraction itself, a tiny fraction (1-2%) composed of tocopherols, phytosterols, pigments, phenolic and aromatic compounds, etc.… would play an important role in the chemical, organoleptic and nutritional properties and stability of olive oil (Kiritsakis *et al.,* 1998; and Martinez *et al.,* 2007).

Olea eurapaea L.*,* or more commonly olive tree, is largely cultivated for the production of its nutritional and healthy fruits. Extra virgin olive oil (EVOO) is an integral ingredient of the Mediterranean diet and a wide number of analytical techniques were used to identify the chemical

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composition (Gomez *et al.,* 2016). These techniques indicated that the fine characteristics, the good health effect, and the biological activity of EVOO are mainly attributed to the presence of the unsaturated fatty acid as major components. They are recognized in olive oils mostly by the presence of the acids: oleic (C18: 1), palmitic (C16: 0), palmitoleic (C16: 1), stearic (C18: 0), linoleic (C18: 2), and linolenic (C18: 3). The high quality of olive is also attributed to the presence in its composition of minor components such as phytosterols, carotenoids, tocopherols and hydrophilic phenols. The major phenolic compounds present in olive oil and conferring it the antioxidation activity belong to the class of secoiridoids mainly represented by oleuropein and ligstroside derivatives, which are strong radical scavengers and are also responsible for bitterness and pungency of EVOO (Ouni *et al.,* 2011 and Genovese *et al.,* 2018).

The importance of virgin olive oil is related to its high level of monounsaturated fatty acids (mainly oleic acid), and several antioxidants (Ocakoglu *et al.,* 2009). The oxidative stability, sensory quality and health properties of virgin olive oil stem from a prominent and well- balanced chemical composition (Bendini *et al.,* 2007). Oil with higher monounsaturated fatty acids (MUFAs) and lower saturated fatty acids (SFAs) are preferred because of the proven beneficial effect of MUFAs on serum cholesterol level (Baccouri *et al.,* 2008). Olive oil quality is related to the chemical composition of the oil, and its oxidative stability and sensory characteristics. These parameters are affected by olive cultivar (Baccouri *et al.,* 2007; Tura *et al.,* 2007 and Mania *et al.,* 2008), climatic conditions (Vinha *et al.,* 2005 and Tura *et al.,* 2007).

The values of the absorptions at the specific wavelengths, 232 and 270 nm, reflect the presence of conjugated dienes and trienes in the olive oil under examination. The production of these molecular species is linked to the oxidation phenomenon or to the refining process. Their rate is expressed through the values of the specific extinction coefficients denoted K_{232} and K_{270} (Conseil Oleicole Internatial, 2001). Compounds of the oxidation of conjugated dienes contribute to the value of K_{232} while K_{270} value contributes to conjugated trienes (Kiritsakis *et al.,* (2002). These spectrophotometric studies in the ultraviolet range can therefore provide information on the quality of the fat, its state of preservation and also show the changes du technological processes.

Phenolic compounds are used as quality markers for virgin olive oil, and they are of great interest due to their anticancer, antiviral, and anti-inflammatory properties (Ghanbari *et al.,* 2012; and Reboredo *et al.,* 2018). Their content is an important factor when evaluating the EVOO quality because they have been correlated with the oil oxidative stability and, in particular, its resistance to lipid peroxidation (Garica *et al.,* 2017; and Oueslati *et al.,* 2018). Extra virgin olive oil quality production could be influenced by several factors, for instance: olive cultivar, geographical region, environmental factors (seasonal conditions), irrigation, olive ripeness, harvestings, storage, and extraction procedure (Jimenez *et al.,* 2013; and Natasa *et al.,* 2018). Light exposure, elevated temperature, and oxygen are all natural adversaries of EVOO and contribute to its deterioration (Salvo *et al.,* 2017).

This work aims to study the effects of geographical location on the chemical composition of olive oil of Frangivento, Corattina and Maraqi cultivars growing in Siwa Oasis and Coratina and Maraqi cultivars growing in Desert Rood.

2. Materials and Methods

2.1. Materials

2.1.1. Olive fruit samples

Olive oil from three olive (*Olea europaea* L.) cultivars growing in Siwa Oasis and two cultivars growing in Desert Rood were used in this study.

2.1.2. Extraction of oil

Healthy olive fruits of all cultivars were hand-picked when the skin of the fruit was black. The oils were extracted from 200 kg of the collected fruits using a mill located in the same region. The mill was equipped with a two-phase extraction system. The extraction of olive oil started with leaf stripping and olive cleaning, and then olives passed into a hammer-crusher to obtain a homogenized olive paste. The malaxation time and temperature of the olive paste were 30 min at 30 °C. After centrifugation, the oil was separated from the paste and water, and then stored in amber glass bottles at room temperature

(15-18 ˚C) in the dark. Soon after the oil extraction, the samples were used in the chemical analytical methods described below.

2.1.3. Solvents and reagents

All solvents used throughout the whole work were analytical grade and distilled before use. Caffeic acid (98%) and Folin-Ciocalteau reagent were purchased from Sigma-Aldrich (St. Louis, MO, USA) and Gerbsaure Chemical Co. Ltd., Germany, respectively.

Sample cod

Sample cod	Varity and location
MOOS	Olive oil obtain from Maraqi cultivar growing in Siwa Oasis
FOOS	Olive oil obtain from Frangivento cultivar growing in Siwa Oasis
COOS	Olive oil obtain from Coratina cultivar growing in Siwa Oasis
MOOD	Olive oil obtain from Maraqi cultivar growing in Desert Rood
COOD	Olive oil obtain from Coratina cultivar growing in Desert Rood

2.2. Methods

2.2.1. Biometric indices

To identify the maturity index of the fruits chosen, the following biometric indices are defined: the fruit total weight and the pit weight.

2.2.2. Quality indices determinations

Free fatty acids (FAA) % and Peroxide value (PV) meq O_2/kg oil were evaluated according to the European Union Commission (1991) Regulation EEC/2568/91

Ultra Violet (UV) absorption was carried out according to IOOC Regulation COI/T20/Dos.No.19/rev. 1 (IOOC 2001). Using a UV spectrophotometer, K232 and K270 were measured, by the absorption at 232 and 270 nm, respectively, in a solution of oil in cyclohexane.

2.2.3. Oxidative stability

Oxidative stability (expressed as the oxidation induction time (hrs)), was measured by a Rancimat 743 apparatus (Metrohm Ω, schweiz AG, Zofingen, Switzerland), using an oil sample of 5g heated to 100 ˚C with air flow of 20 L/h. according to the procedure described by Tura *et al.,* (2007).

2.2.4. Fatty acid composition

The fatty acids composition was determined as methyl-esters by gas chromatography (GC). Fatty acid methyl esters were prepared by vigorous shaking of a solution of olive oil samples in hexane (0.2 g in 3 ml) with 0.4 ml of 2N methanolic potassium hydroxide solution (IOOC, 2001). Chromatographic analysis was performed on a Hewlett Packard 5890N gas chromatograph equipped with a FID detector (Hewlett Packard, Palo Alto, CA, USA), using a flused-silica capillary column (30 m × 0.25 µm i.d × 0.25 µm film thickness, HP Supelco, Inc., Bellefonte, PA, USA). The injector and detector temperatures were maintained at 220 ˚C and 260 ˚C, respectively; the oven temperature was set at 210 ˚C. Helium was employed as the carrier gas with a flow rate of 1 mL/min. Fatty acids were identified by comparing retention times with those of standard compounds.

2.2.5. Total phenols

Total phenolic content was determined following the procedure indicated by Montedoro *et al.,* (1992) by the Folin-Ciocalteau spectrophotometric method (Jenway/6405 UV-England, 1997) at 765 nm, and results were expressed as milligram Caffeic acid per kilogram oil.

2.2.6. Identification and determination of phenolic fraction

Identification and determination of phenolic fraction of olive oil samples were carried out by analyzing the phenolic extracts with HPLC using Caffeic acid as an internal standard. A Shimadzu model HPLC system (Shimadzu Corp., Kyoto, Japan) was used, consisting of a solvent delivery module (LC-10 AD) with a double-plunger reciprocation pump, UV-VIS detector (SPA-10A), and column oven (CTO-10A). The column used was Apex octadecyl 104 C_{18} (25cm× 0.4cm ID) with 5 µm packing

(Jones Chromatography, Lakewood, Colo., U.S.A.). Phenolic fraction compounds were identified and determined by method described by Schieber *et al.,* (2001).

2.2.7. Sensory analysis

A sensory analysis (median of defects, median of fruity and panel classification test) of the samples was carried out by 8 trained panelists, according to the method described in Regulation EEC 640/ 2008 (European Union Commission, 2008). The intensities of both positive (fruity, bitter and pungent) and negative (fusty, winy, musty, muddy, rancid, metallic, and other) attributes were evaluated for each oil sample, on a non-structured, 10 cm scale. The different attributes of the oils were assessed and their intensities were evaluated as a median value of the panelists score.

2.3. Statistical analysis

Data were subjected to the statistical analysis according to Analysis of Variance (ANOVA) of Completely Randomized Design as described by Gomez and Gomez, (1984) Treatment means were compared using the Least Significant Differences (LSD) at 0.05 levels of probability.

3. Results and Discussion

3.1. Variety, original country, yield, uses biometric indices

The average fruit fresh weight is a crucial agronomic parameter for a preliminary selection of variety for table olive, oil destination or even both uses. A great variability in the means of the average fruit fresh weight was observed among the studied olive varieties (Table 1) it ranged from a minimum of 3.11 g (FOOS) to 4.53g (COOD). Oil yield does not constitute a criterion of oil quality determination but especially a criterion to be envisaged during the varietal selection.

3.2. Biometric indices

The biometric indices of fruit emerge as varietal characteristics (Table 1). These indices show a highly significant variation ($P<0.05$) according to the maturity of the fruit and the variety.

The trend of the fruit weight, according to the olives maturity is outstanding in these cultivars. Maraqi and Coratina growing in Desert Rood are characterized by the highest values 4.22 g and 4.53 g compared to Frangivento, Coratina and Maraqi growing in Siwa Oasis which the values varieties from 3.11g to 3.85 g

The fruit weight/pit weight ratio provides values which have enabled one to categorize the studies varieties into two groups:

1. Maraqi, Coratina and Frangivento varieties growing in Siwa Oasis with the lowest value ranged between 7.46 to 7.65
2. Maraqi and Coratina varieties growing in Desert Rood with the higher value 8.27 and 8.08. The difference noted on the level in the studied parameters is related to the genetic inheritance of each variety, which has a significant incidence according to Michelakis, (1995). Cultural conditions may have a role in modifying these parameters without modifying the varietal characteristics of origin (Michelakis, 1995).

Table 1: Variety name, original country, uses and average fruit weight and olive oil yield

Olive varieties	Original site	Uses	Yield (%)	FW (g)	PW (g)	FW/PW
COOS	Italy	Oil	$14.00^{b}\pm0.13$	$3.57^{b}\pm0.03$	$0.49^{b}\pm 0.01$	$7.65^{b}\pm0.06$
FOOS	Italy	Oil	$15.10^{a}\pm2.04$	$3.11^{c}\pm0.01$	$0.42^{b}\pm0.04$	$7.46^{b}\pm0.02$
MOOS	Egypt	Oil	$13.50^{c}\pm1.15$	$3.85^{b}\pm0.01$	$0.51^{a}\pm0.01$	$7.50^{b}\pm0.01$
COOD	Italy	Oil	$14.51^{b}\pm2.01$	$4.53^{a}\pm0.02$	$0.56^{a}\pm0.01$	$8.08^{a}\pm0.04$
MOOD	Egypt	Oil	$13.98^{b}\pm1.01$	$4.22^{a}\pm0.01$	$0.51^{a}\pm0.03$	$8.27^{a}\pm0.11$

Different letters in the same column indicate significantly different at $P< 0.05$.
Each value represents the mean of three determinations (n=3) ± standard deviation.
FW: Fruit Weight PW: Pit Weight.

Regarding oil yield, the highest content of oil yield was found in FOOS (15.1%) followed by COOD (14.51%) and COOS (14.0%), meanwhile oil yield from (MOOS and MOOD) show lower

content 13.5% and 13.98% respectively. Statistical analysis showed significant differences in oil yield content between cultivars from different geographical locations (P<0.05).

3.3. Quality indices, total polyphenol and oxidative stability of olive oil samples

Quality parameters of olive oils sample from the studied cultivars are shown in Table (2). Statistically significant differences were obtained in free acidity, peroxide value, K232 and K270 between oils from the studied cultivars (P< 0.05). The maximum level of free acidity was in COOS (0.49%) while COOD had the lowest free acidity (0.28%). The peroxide value of the samples was in the range of 6.12 to 9.84 meq O_2/ kg. K232 and K270 coefficients ranged from 0.65 to 1.53 and from 0.056 to 0.091 respectively. Spectrophotometric absorption values at 232 nm and 270 nm for oils from all olive variety under study were below the limit of 0.22, and 2.5 set by the IOOC for extra virgin olive oil (IOC, 2018). The content of peroxide value from MOOS and COOD cultivars were significantly higher (9.84 and 8.10 meq O_2/ kg) than COOS showed significantly the lowest (6.12 meq O_2/ kg). It is clear that peroxide value of all olive oils samples was under the value of 20 meq O_2/ kg of olive oil, which is the maximum established by the (IOC, 2018). This behavior can be explained by a difference in the activity of the enzyme lipoxygenase in these cultivars. All the oil samples were characterized by quality indices (FA, PV, K232 and K270) under the maximum limits for extra virgin olive oil quality grade fixed by the (IOC, 2018). These high-quality indices are translated into a high quality of oils which could be due to the use of healthy fruits and typically small scale of system used for the processing procedures. The basic physicochemical parameters FA, PV, K232 and K270 were apparently affected by olive variety and the growing area of olive tree (Mania *et al.,* 2008).

Total polyphenol content of the olive oil showed significant differences between the olive oil cultivars with the highest level obtained from the two cultivars growing in desert rood (COOD and MOOD). Olive oil from cultivars growing in Siwa Oasis (MOOS, COOS and FOOS) show lower polyphenol content compared to the other varieties (Table 2).

Table 2: Quality indices, total polyphenol and oxidative stability of olive oil samples

Regions	**Siwa Oasis olive varieties**			**Desert Rood olive varieties**	
Quality parameters	**FOOS**	**COOS**	**MOOS**	**COOD**	**MOOD**
Free acidity (% oleic acid)	0.31^{a}±0.11	0.49^{c}± 0.06	0.4^{b}±0.03	0.28^{a}±0.07	0.33^{a}± 0.04
Peroxide value (meq O_2/ kg oil)	7.59^{b}±0.14	6.12^{a}±0.10	9.84^{d}± 0.03	8.10^{c}±0.02	7.56^{b}±0.15
K232	0.65^{a}±0.07	0.89^{b}±0.04	0.96^{c}±0.03	1.31^{d}±0.08	1.53^{d}±0.06
K270	0.083^{b}±0.02	0.077^{b}±0.01	0.09^{c}±0.01	0.06^{a}±0.02	0.056^{a}±0.01
Total polyphenols (mg/ kg)	187.52^{b}±0.16	139.31^{d}±0.22	168.41^{c}±0.2	188.1^{b}±0.55	211.05^{a}±0.7
Oxidative stability (hrs)	20.12^{a}±0.08	17.80^{c}±0.13	19.40^{b}±0.09	20.50^{a}±0.12	21.80^{a}±0.15

Different letters in the same row indicate significantly different at P< 0.05
Each value represents the mean of three determinations (n=3) ± standard deviation

Virgin olive oil is well known for its high content of phenolic substances. Virgin olive oil contains phenolic compounds which affect its stability and flavor. As shown in Table (2) significant differences among olive oil samples of five olive varieties was observed (P< 0.05). Among them MOOD had the highest total phenol content (211.05 mg/ kg) as Caffeic acid equivalents, while COOS had the lowest (139.31 mg/ kg) as Caffeic acid equivalents. Also, COOD and FOOS olive oils had intermediate content of total phenols (188.1 and 187.52 mg/kg) as Caffeic acid equivalents. Study by Cerretani *et al., (*2006) reported that the phenolic composition was found to be not useful in discriminating the olive oil samples due to the fact that the phenolic content of oils was affected not only by the olive cultivars, but also by the climatic and environmental conditions. The total phenol content values agree with that reported by Negro *et al.,* (2019) reported values between 138 and 278 mg/kg for virgin olive oils produced in Lecce, Italy. Statistical analysis showed significant differences in total phenol content between the oil samples from different geographical locations (P< 0.05). Our results revealed that geographical location of olive cultivars had a significant effect and total phenol in the oil, which is in agreement with the finding of Mansour *et al.,* (2015). In the same line Del Monaco *et al.,* (2015) reported that the total phenols content showed large variation with regard to geographical locations.

Induction period (oxidative stability) is useful measurement for comparing the relative stability of different oils and therefore considered to be a good tool for evaluating the resistant of olive oil to

oxidation (Kiritsakis *et al.,* 2002). The induction periods of olive oil extracted from three varieties olive (Maraqi, Coratina, and Frangivento) growing in Siwa Oasis and two varieties (MOOD and COOD) growing in Desert Rood were determined and the results are shown in Table (2). From the obtained data, it could be observed that a positive relation with phenolic content and oxidative stability. As shown in Table (2), the highest level of oxidative stability was recorded to the oil samples of COOD (20.5h), followed by MOOD (21.8h) while COOS recorded the lowest value (17.8h).

3.4. Fatty acid composition

The main fatty acids were detected in all olive oil samples obtained from two different regions Siwa Oasis (Maraqi, Frangivento and Coratina) and Desert Rood (Maraqi and Coratina). As shown in Table (3), Oleic (C18:1), Palmitic (C16:0), Linoleic (C18:2) and Stearic acids (C18:0) were the major fatty acids found in all olive oil samples. Generally, fatty acids were within the limits for olive oil from IOC (2015). Oleic acid the major monounsaturated fatty acid showed a wide variability depending on the cultivars in too regions. The relative contents of Oleic acid varied from 71.63% (FOOS) to 76.0% (MOOD). Palmitic acid ranged between 9.81% (MOOD) and 11.2% (COOS). The highest content of linoleic acid was found in FOOS (11.51). Regarding the ratio of monounsaturated to polyunsaturated fatty acids (MUFA/ PUFA), a significant difference between samples ($P<0.05$) was obvious between two regions (Table3). The highest ratio of MUFA/ PUFA was registered in the olive oil samples from MOOD and MOOS (7.20% and 7.61% respectively).

The difference observed between samples of olive oil in relation to the fatty acid composition may be explained by the geographical location, which agrees with the findings of Mansour *et al.,* (2015). It is probably attributed to genetic factors and also to environmental conditions during fruit growth and ripening as suggested by Piravi-Vanak *et al.,* (2012) proved that the fatty acid composition of olive oil is crucially influenced by the variety, latitude, fruit ripening and climatic conditions. Mansour *et al., (*2015) reported that the nutritional benefits are mainly attributed to the fatty acid composition, particularly to both great concentration of oleic acid and the ratio saturated/ polyunsaturated fatty acids. Moreover, the high stability of COOD, MOOD and FOOS is also probably due to relatively low contents of PUFA and high contents of MUFA. In fact, Aguilera *et al.,* (2005) reported that oil samples with great MUFA/PUFA ratio showed higher stability to oxidation.

Table 3: Fatty acid composition of different cultivars of olive oil

Regions	**Siwa Oasis olive varieties**			**Desert Rood olive varieties**	
Fatty acid composition %	**MOOS**	**COOS**	**FOOS**	**COOD**	**MOOD**
Myristic acid C14:0	0.02	ND	0.01	ND	0.01
Palmitic acid C16:0	11.12	11.21	10.78	10.12	9.81
Palmitolic acid C16:1	0.71	0.56	0.45	0.23	0.29
Margaric acid C17:0	0.06	0.06	0.07	0.05	0.04
Heptadecenoic acid C17:1	0.08	0.11	0.09	0.08	0.07
Stearic acid C18:0	1.71	2.62	3.66	2.64	2.32
Oleic acid C18:1	75.32	73.54	71.63	75.11	76.00
Linoleic acid C18:2	9.17	10.19	11.51	10.12	9.80
Linolenic acid C18:3	0.88	0.89	0.90	0.86	0.84
Arachidic acid C20: 0	0.47	0.42	0.46	0.39	0.31
Eicoseneoic acid C20:1	0.32	0.30	0.31	0.29	0.30
Behenic acid C22:0	0.14	0.10	0.13	0.11	0.21
∑SFA	13.52	14.41	15.11	13.31	12.70
∑MUSFA	76.43	74.51	72.48	75.71	76.66
∑PUSFA	10.05	11.08	12.41	10.98	10.64
MUSFA/ PUSFA	7.60	6.72	5.84	6.89	7.20
SFA/ PUFA	1.34	1.30	1.21	1.21	1.91

ND: Not detect

3.5. Quantification of phenolic compounds

Virgin olive oil is virtually containing large amounts of natural phenolic compounds. These compounds are responsible for its distinctive bitter yet fruity taste and largely determine its stability by

enhancing its resistance to oxidation. This parameter is very important, particularly to the organoleptic quality and keeping properties of the oil.

Table (4) summarizes the information about the phenolic compounds identified in the studied olive oil samples. The results revealed that fourteen phenolic components were identified in all olive oil samples. Oleuropein, Hydroxytyrosol, *p*-Coumaric acid, Tyrosol and Oleocein were the predominant phenolic compounds in all olive oil samples.

The main phenolic compound was Oleuropein with contents varying from 58.11 mg/kg to 12.78 mg/kg, together with Hydroxytyrosol that ranged from 31.31 mg/kg to 22.02 mg/kg, *p*-Coumaric was found in a range of 17.51 mg/kg to 42.11 mg/kg, Tyrosol showed the highest content (21.51 mg/kg) in MOOD and the lowest content (12.02 mg/kg) in COOS.

In the group of phenolic acids, the amounts of the compounds were less abundant in olive oils than the amount of the secoirridoids group. Caffeic acid, Ferulic acid, Vanillic acid, and *p*-hydroxybenzoic acid were the phenolic acids found in the oils with small amounts.

In general, all the samples showed lower concentrations of phenolic acids, if compared to the other cultivars of the countries of the Mediterranean basin (Di Stefano *et al*., 2020) and (Grilo and Novara 2020).

We suggest that the composition in phenolic compounds of the oils under study could be higher if the harvesting time is done earlier; previous studies demonstrated that olives have the highest phenolic compound content at the phase between green and darker skin (Bakhouche *et al*., 2015 and Bengana *et al*., 2013).

Table 4: Phenolic compounds composition (mg/kg) of different cultivars of olive oil

Regions	**Siwa Oasis olive varieties**			**Desert Rood olive varieties**	
Phenolic compounds	**MOOS**	**COOS**	**FOOS**	**COOD**	**MOOD**
		Phenolic alcohol			
Hyboxytyrosol	31.12	ND	22.42	31.31	26.20
Tyrosol	16.05	12.02	15.21	18.26	21.51
		Phenolic acids			
***p*-Coumaric acid**	35.12	23.17	17.51	42.11	27.31
Caffeic acid	7.28	4.50	5.21	9.19	10.11
Vanillic acid	ND	3.15	ND	3.33	5.16
Ferulic acid	3.12	2.21	3.13	4.05	4.14
Cinnamic acid	1.11	ND	ND	1.51	2.51
***p*-Hydroxybenzoic acid**	ND	ND	1.33	1.82	1.13
		Secoiridoids			
Oleuropein	32.12	41.01	12.78	58.11	43.02
Oleocein	15.00	13.50	8.88	19.12	21.57
		Flavonoids			
Apigenin	2.32	4.15	3.15	5.24	3.50
Luteolin	1.40	4.02	4.10	5.05	6.09
Un known	2.81	3.34	2.11	4.45	3.11
Un known	3.14	2.45	3.41	3.88	5.01

ND: Not detect

3.6. Sensory evaluation

Results in Table (5) shows the sensory attributes of olive oil samples obtained from five varieties olive (FOOS, COOS, MOOS, COOD and MOOD). The results revealed that no defect in any of the studied oils and they are classified as virgin olive oils. Data from sensory analysis of oils from three varieties growing in Siwa oasis were less fruity, less bitter, and less pungent than those of oils extracted from COOD and MOOD varieties. Olive oils of COOD and MOOD showed higher perception of bitterness and fruity than the oils growing in Siwa Oasis. These obtained results demonstrated that there was a good correlation between total polyphenol content and sensory properties of the olive oil. This is confirmed by observations of (Kiritsakis *et al*., 1998).

Table 5: Sensory evaluation of different cultivars of olive oil

Regions	Siwa Oasis olive varieties			Desert Rood olive varieties	
Olive varieties	**FOOS**	**COOS**	**MOOS**	**COOD**	**MOOD**
Fruity	$4.8^{c}\pm0.36$	$5.4^{b}\pm0.30$	$5.2^{b}\pm0.51$	$6.1^{a}\pm0.54$	$6.6^{a}\pm0.05$
Bitter	$3.1^{b}\pm0.41$	$4.4^{a}\pm0.22$	$4.1^{a}\pm0.23$	$4.5^{a}\pm0.30$	$4.2^{a}\pm0.41$
Pungency	$2.8^{c}\pm0.31$	$3.0^{c}\pm0.18$	$3.4^{b}\pm0.25$	$4.1^{a}\pm0.31$	$3.7^{a}\pm0.21$
Defects	0	0	0	0	0

Different letters in the same row indicate significantly different at $P< 0.05$
Each value represents the mean of three determinations (n=3) ± standard deviation

Conclusions

The geographic area of origin appears to play a significant role for the qualitative characteristics and the sensory attributes of the olive oils analyzed. The results obtained showed that olive oils coming from Siwa Oasis and Desert Rood were free from any defects and were classified as extra virgin olive oil according to International Olive Council, acidity, and peroxide values were within the limits for virgin olive oil. The physical and chemical characteristics of olive oils samples showed somewhat considerable differences, but have good properties as they contain low percentages of acidity, and it contains high monounsaturated to saturated fatty acids ratio that Oleic acid is monounsaturated and therefore contributes to that stability and however, Linoleic and Linolenic acids, despite their perceived nutritional benefits are both susceptible to oxidation as they are polyunsaturated

References

Aguilera, M.P., G. Beltrain, D. Ortega, A. Fernandez, A. Jimenez and M. Uceda, 2005. Characterization of virgin olive oil of Italian olive cultivars: Frantoio and Leccino grown in Andalusia. Food Chem., 89: 387-391.

Artajo, L.S., M.P. Romero, J.R. Morelloa and M.J.J. Motilva, 2006. Enrichment of refined olive oil with phenolic compounds: Evaluation of their antioxidant activity and their effect on the bitter index. J. Agric. Food Chem., 54: 6079- 6088.

Baccouri, B., S. Temime, E. Campeol, P. Lcioni, D. Daoud and M. Zarrouk, 2007. Application of solid-phase micro extrication to the analysis of volatile compounds in virgin olive oils from five new cultivars. Food Chem., 102: 850- 856.

Baccouri, O., M. Guerfel, B. Baccouri, L. Cerretani, A. Bendini, G. Lercker and M. Zarrouk (2008). Chemical composition and oxidative stability of Tunisian monovarietal virgin olive oils with regard to fruit ripening. Food Chem., 109: 743- 754.

Bakhouche, A., J. Lozano, M. Bengana, A. Fernandez and A. Segura, 2015. Time course of Algerian Azeradj extra virgin olive oil quality during olive ripening. Eur. J. Lipid Sci. Technol., 117: 389-397.

Bendini, A., L. Cerretani, A. Carrasco, A. Gomez, A. Segura, A. Fernandez and L. Giovanni, 2007. Phenolic molecules in virgin olive oils: A survey of their sensory properties, health effects, antioxidant activity and analytical methods. An over view of the last decade. Molecul., 12: 1679-1719.

Bengana, M., A. Bakhouche, J. Lozano, Y. Amir, A. Youyou, A. Segura and A. Fernandez, 2013. Influence of olive ripeness on chemical properties and phenolic composition of Chemlal extra virgin olive oil. Food Res. Int., 54: 1868: 1875.

Cerretani, L., A. Bendini, A. Del Caro, A. Piga, V. Vacca, and M.F. Caboni, 2006. Preliminary characterization of virgin olive oils obtained from different cultivars in Sardinia. Europ. Food Research Tech., 222: 354-361.

Conseil Oleicole International, 2011. COI/ T. 15/ NC (2/ Rev. 10)

Del Monaco, G., A. Officioso, S. D'Angelo, *et al.,* 2015. Characterization of extra virgin olive oils produced with typical Italian varieties by their phenolic profile. Food Chemistry, 184: 220-228.

Di Stefano, V., and M. Melilli, 2020. Effect of storage on quality parameters and phenolic content of Italian extra virgin olive oils. Nat. Prod. Res., 34: 78-86

European Union Commission, 1991. Regulation (ECC) No. 2568/91. *Official Journal of the European Communities, L 248.*

European Union Commission, 2008. Characteristics of olive oil and olive- residue oil and on the relevant methods of analysis Regulation EEC/ 640/ 2008. O. J. Eur. Comm. L 178, 11- 16.

Garcia, R., A. Belaj, C. Romero, C. Sanz and A. Perez, 2017. Exploration of genetic resources to improve the functional quality of virgin olive oil. J. Funct. Foods, 38: 1- 8.

Genovese, A., N. Yang, R. Linforth, R. Sacchi and I. Fisk, 2018. The role of phenolic compounds on olive oil aroma release. Food Res. Int., 112: 319- 327.

Ghanbari, R., F. Anwar, K. Alkharfy, A. Gilani and N. Saari, 2012. Valuable nutrients and functional bioactive in different parts of olive (*Olea eurapaea* L.). Int. J. Mol. Sci., 13: 3291- 3340.

Gomez, K.A. and A.A. Gomez, 1984. Statistical Procedures in Agricultural Research New York, Chichester, etc.: Wiley 2nd edition.

Gomez, A.M., R.M. Maggio and L. Cerretani, 2016. Chemometric applications to assess quality and critical parameters of virgin and extra virgin olive oil. Anal. Chim. Acta, 913: 1- 21.

Grilo, F., M. Novara, M. D'Oca, S. Rubino, R. Lo Bianco, and V. Di Stefano, 2020. Quality evaluation of extra virgin olive oils from Sicilian genotypes grown in a high-density system. Int. J. Food Sci. Nutr., 71: 397-409.

Gutierrez, F., 1989. Determinacion de la estabilidade oxidative de aceites de oliva virgenes: Comparacion entre del metodo A. O. M. yel metodo Rancimat. Grasas. Aceites, 40: 1- 5.

IOOC (International Olive Oil Council), 2005. Method IOOC for the organoleptic assessment of virgin olive oil. XV International course on the improvement of olive oil quality (Cairo, Egypt, 20 February 2005).

IOOC (International Olive Oil Council), 2001. Preparation of the fatty acid methyl ester from olive oil and olive pomace oil. International Olive Oil Council, Madrid.

IOOC (International Olive Oil Council), 2018. Trade Standard Applying to Olive Oils and Olive Pomace Oils. COI/T.15/NC NO 3/Rev. 12 June 2018.

IOOC (International Olive Oil Council), 2018. Sensory analysis of olive oil method for the organoleptic assessment of virgin olive oil; COI/T.20/Doc.No 15/Rev. 10; International Olive Council (IOC): Madrid, Spain, 2018.

Jimenez, B., A. Sanchez, M. Lorenzo and A. Rivas, 2013. Influence of fruit ripening on agronomic parameters, quality indices, sensory attributes and phenolic compounds of picado olive oils. Food Res. Int., 54: 1860- 1867.

Kiritsakis, A., A. Kanavouras and K. Kiritsakis, 2002. Eur. J. Lipid Sci. Tech., 104: 628- 638.

Kiritsakis, A., G. Nanos, Z. Polymenoupoulos, T. Thomai and E. Sfakiotakis (1998). Effect of fruit storage conditions on olive oil. J. Am. Oil Chem. Soc. 75: 721- 724.

Mania, H., F. Haddada, I. Oueslati, D. Daoud and M. Zarrouk, 2008. Characterization of monvarietal virgin olive oils from six crossing varieties. Sci. Hort., 115: 252- 260.

Mansour, A.B., B. Gargouri, G. Flamini, and M. Bouaziz, 2015. Effect of agricultural sites on differentiation between Chemlali and Neb Jmel olive oils. J. Oleo Sci., 392: 381- 392.

Martinez-Vidal, J.L., A. Garrido-Frenich, M.A. Escobar-Garcia and R. Romero-Gonzales, 2007. LC-MS determination of sterols in olive oil. Chromatographia., 65: 695- 699.

Michelakis, N., 1995. Effet des disponiblites en eau sur la croissance et le rendement des oliviers. Olivae, (56): 29-39.

Montedoro, G.F., M. Servili, M. Balbioli and E. Miniati, 1992. Simple and hydrolysable phenolic compounds in virgin olive oil. 2. Initial characterization of the hydrolysable fraction. J. of Agri. and Food Chem., 40: 1577- 1580.

Natasa, P., A. Reza and S. Nikolaos, 2018. Application of an advanced and wide scope non-target screening workflow with LC-ESI-QTOF-MS and chemometrics for the classification of the Greek olive oil varieties. Food Chem., 256: 53- 61.

Negro, C., A. Aprile, A. Luvisi, F. Nicoli, E. Nutricati, M. Vegine, and A. Miceli, 2019. Phenolic profile and antioxidant activity of Italian monovarietal extra virgin olive oils. Antioxidants, 8: 161-170.

Ocakglu, D., F. Tokatli, B. Ozen and F. Korel, 2009. Distribution of simple phenols, phenolic acids and flavonoids in Turkish monovarietal extra virgin olive oils for two harvest years. Food Chem., 113: 401- 410.

Oueslati, I., D. Krichene, H. Manai, W. Taamalli, M. Zarrouk and G. Flamini, 2018. Monitoring the volatile and hydrophilic bioactive compounds status of fresh and oxidized Chemlali. Food Res. Int., 112: 425- 433.

Ouni, Y., A. Taamalli, A. Maria Gomez-Caravaca, A. Segura, A. Fermandez and M. Zarrouk, 2011. Characterization and quantification of phenolic compounds of extra virgin olive oils according to their geographical origin by a rapid and resolutive LC-ESI-TOF MS method. Food Chem., 127: 1263- 1297.

Piravi-Vanak, Z., J.B. Ghasemi, M. Ghavami et al., 2012. The influence of growing region on fatty acids and sterol composition of Iranian olive oils by unsupervised clustering methods. J. of Amer. Oil Chem. Society, 89: 371-378 .

Reboredo, P., A. Varela, T. Forbes, M. Gasparrini, S. Afrin, D. Cianciosi, J. Zhang *et al*., 2018. Phenolic compounds isolated from olive oil as nutraceutical tools for the prevention and management of cancer and cardiovascular diseases. J. Funct. Foods, 19: 2305.

Salvo, A., A. Rotondo, G. La Torre, N. Cicero and G. Dugo, 2017. Determination of 1, 2/ 1,3-diglycerides in Sicilian extra virgin olive oils by ^{1}H-NMR over a one-year storage period. Nat. Prod. Res., 31: 822- 828.

Schieber, A., P. Keller and R. Carle, 2001. Determination of phenolic acids and flavonoids of apple and pear by high performance liquid chromatography system. J. of Chromatography A, 910: 265-273.

Tura, D., C. Gigliotti, S. Pedo, O. Failla, D. Bassi and A. Serraiocco, 2007. Influence of cultivar and site of cultivation on levels of lipophilic and hydrophilic antioxidants in virgin olive oils (*Olea europaea*) and correlation with oxidative stability. Sci. Hort., 112: 108- 109.

Vinha, A., F. Ferreres, B. Silva, P. Valentao, A. Goncalves and J. Pereira, 2005. Phenolic profiles of Portuguese olive fruits (*Olea europaea* L.): Influences of cultivar and geographical origin. Food Chem., 89: 561- 568.