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Comparative Study of the Quality of Extra Virgin Olive Oil in the Egyptian Market (from different Mediterranean countries)

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ABSTRACT

The present study was carried out to assess the quality criteria (physic-chemical and sensory evaluation) , oxidative stability, fatty acids composition and phenolic compounds of some olive oil samples declared as "Extra virgin olive oil" (EVOO) sold in the domestic Egyptian market which are imported from popular major producer in Spain, Italy, Greece, Syria, Tunisia and also the Egyptian olive oil. Results of physicochemical characteristics revealed that 66.66 % of olive oil samples declared as "Extra virgin olive oil" presented quality characteristics non compliance with IOC Trade Standard, 2016 for EVOO category regarding results of K232 and K270 which had high significant differences and revealed that four EVOO country brands were exceeded the permitted limits of EVOO. Almost, fatty acid profiles were in the range of virgin olive oil for all samples except trans fatty acids for C18:2 were above the limits of IOC Standard in Syrian, Tunisian and Egyptian EVOO brands. The study indicated that sensory analysis is an essential criteria for the official control of EVOO quality parallel with physicochemical quality criteria. Based on sensory analysis limits results showed that only 3 samples of six not conform to the grade declared EVOO quality criteria and presented a sensory profile with defects. It can conclude that, Physicochemical analysis help in confirmed the negative sensory results and vice versa.

Key words: Extra virgin olive oil, physic-chemical analysis, Sensory evaluation Fatty acids, Phenolic compound.

Introduction

Olive oil is an important foodstuff constituting a major part of daily food regimes. This oil is extracted from *Olea europaea* tree belonging to family *Oleaceae*. Virgin olive oil refers to oils that are extracted merely by pressure and other mechanical processes and no other treatments (Najaf *et al.*, 2015). Virgin olive oils can control blood cholesterol level due to its sufficient amounts of essential fatty linoleic and oleic acids and anti-oxidative compounds. It also reduces the risk of cardiovascular diseases and cancers by decreasing the penetration rate of fatty acids in to artery walls (Silva *et al.*, 2010). Processing remarkably decreases bioactive compounds of olive oil, such as phenols, tocopherols, sterols, and pigments, and also has a great effect on its sensory properties. Tocopherols and phenolic compounds are effective antioxidants whose initial amounts play a crucial role in inhibiting primary and secondary lipid oxidation (Uyor and Ori- Jesu 2008). Phenolic compounds are more effective than tocopherols in enhancing the stability of olive oil against oxidation (İnanç and Maskan 2012). The unique balanced chemical structure of olive oil may bring about positive effects on human health, a high oxidative stability, appealing taste and odor. Additionally, the favorable effects of olive oil are to a large extent produced by the presence of antioxidants such as phenols, tocopherols, pigments, and fatty acids with one unsaturated bond (El Riachy *et al.*, 2011). It seems suitable to use the olive oil in thermal processes since it contains high amounts of mono unsaturated fatty acids (MUFAs), low saturated fatty acids (SFAs) and poly unsaturated fatty acids (PUFAs), very low linolenic acids, and no trans fatty acids (Al-bachir *et al*., 2016). The type and amount of different chemicals in the olive oil are the indicators of its quality, which, in turn, depends to multiple factors

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including variety, climate, extraction method, and the fruit's ripening stage (Alcázar Román *et al*., 2014). In order to analyze the influence of climatic conditions, Aguilera *et al.* (2005) showed that locations with the high temperature and low altitude could be associated with an increased polyunsaturation and the lowest oleic percentage. This could be attributed to a modification of lipid biosynthesis coinciding with a wet summer. The metabolism and lipid levels of the olive fruit are affected by environmental factors such as light, temperature, and water stress. Extra virgin olive oil is imported from major and popular producers from Mediterranean countries, Spain, Italy and Greece etc. under different names and brands .While there are many excellent imported and domestic extra virgin olive oil in the Egyptian markets. The quality levels of the imported and Egyptian olive oil brands will differ and it has to examine to be meet the international standards due to ensure the quality and category as mentioned in the label. Accordingly, this study aimed to present the results of quality criteria evaluation; physicochemical properties and sensory assessment as well as oxidative stability and phenolic compounds of some brands of olive oil samples declared as Extra virgin sold in the Egyptian market and produced in Mediterranean countries from different cultivars from Spain, Italy, Syria, Greece, Tunisia and Egypt. In order to control the conformity of "Extra virgin olive oil" to the declared category, based on the international standard and differentiation of the olive oils within the grade EVOO.

Material and Methods

The different brands of olive oil samples labeled as "Extra virgin olive oil" were obtained from domestic retail Egyptian market which were imported from popular major producer from Spain, Italy, Greece, Syria , Tunisia and also, the Egyptian olive oil. Samples were obtained during the period of 01/01/2016 to 30/01/2016. The physicochemical indices were analyzed using official methods and the sensory evaluation were performed by Egyptian panelists from Food Technology Research Institute which was officially recognized by IOC and using IOC sensory evaluation method.

All chemicals, reagents and solvents used in this study were analytical grade and obtained from Sigma agent and Cornal Lab Companies in Egypt.

Analytical methods:

Refractive index (RI):

Refractive index was determined according to the method described by AOAC (2000) using a refract meter (NY RL-3-Poland).

Free Fatty acids (FFA%):

Free acidity, expressed as percent of oleic acid (% C18:1), was determined by titration of the solution of oil dissolved in ethanol/petroleum ether (1:1, v/v) with 0.1 M potassium hydroxide ethanolic solution. The value was evaluated according to the official methods described in the European Union Commission Regulations EEC/2568/91 and EEC/1429/92.

Peroxide value (PV):

Peroxide value, given in mill equivalents of active oxygen per kilogram of oil (meq. O2 kg^{-1}). It gives a measure of the extent to which an oil sample has undergone primary oxidation. The value was determined as follows: a mixture of oil and chloroform/glacial acetic acid (3:2, v/v) was left to react in darkness in a saturated potassium iodide solution; the free iodine was then titrated with a sodium thiosulfate solution. The value was evaluated according to the official methods described in the European Union Commission Regulations EEC/2568/91 and EEC/1429/92.

Iodine value (IV):

The iodine value was determined using the Hanus method as described by AOAC (2000).

Saponification value (SV):

Saponification value was determined according to the AOAC (2000).

Oxidative stability (OST):

Oxidative stability was evaluated by the Rancimat method (Gutièrrez, 1989). Stability was expressed as the oxidation induction time (hr), measured with the Rancimat 743 apparatus (Metrohm Ω, Basel, Switzerland), using an oil sample of 3 g heated to 100ºC and an air flow of 20 L hr^{-1}.

Fatty acid composition:

The methyl-esters of fatty acids were prepared from olive oil, and after cold saponification by vigorous shaking of a solution of oil in hexane (0.2 g in 3 ml) with 0.4 mL of 2 N methanolic potassium hydroxide (IOOC, 2001).

Determination and Identification of Phenolic Fraction of olive oil Using HPLC:

Phenolic fraction compounds were identified determined by the method described by (Schieber *et al.,* 2001).

Organoleptic test:

The organoleptic test was determined for the olive oil samples according to the International Olive Oil Council (IOC, 2015). The oil samples (15 ml) were presented in covered blue glasses (diameter, 70 mm, capacity, 130 ml) at 28˚C ± 2˚C. The glass warmed and after removing the cover, the samples were smelled and then tested by the trained panelists. The organoleptic assessment of virgin olive oil were conducted according to the method (profile sheet) described by IOC, (2015) using IOC profile sheet. The different attributes of the oils were assessed and their intensities were evaluated as a median value of the panelists score.

Statistical analysis:

A) Data obtained throughout this study were statistically analyzed using the analysis of variance method as reported by Snedecor and Cochran (1980) and the differences between means were differentiated by using Duncan's range test.

B) Data of sensory evaluation were analyzed by the analysis of variances using the general linear model (GLM) procedure within a package program of the statistical analysis system (Copyright 1987), SNS institute Znc. Carry, NC, 2755128, USA, SAS proprietary software, release 6.03). Specific differences between treatments were determined by LSD test for each attribute. Results were tested for degree of significant level at $P<0.05$.

Results and Discussion

Physicochemical quality criteria:

Adulteration of fats and oils by mixing with cheap oils or with low grade and quality from the same type of oils is an old problem. Many older tests involved determination of physical properties such as refractive index (Shahidi, F., 2005). Traditional analytical techniques, absorption in UV light, and fatty acid composition were selected due to their simplicity and popularity in the quality control of olive oil.

Refractive Index (RI), free acidity % (FA), peroxide value (PV), iodine value (IV), saponification value (SV), absorbency in UV ($K^{1\%}_{1cm}$) and induction period (IP) were presented in Table (1).

Knowledge of the refractive index of aqueous solutions and oil is of crucial importance in applications of identity and adultration of oils and their purity (Yunus *et al.,* 2009).The refractive index of oils depends on their molecular weight, fatty acid chain length, degree of unsaturation, and degree of conjugation. Values of refractive index for different oils generally vary between 1.447 and 1.482 (Shahidi, 2005).

Virgin olive oil exhibited RI value with the international accepted limits for olive oil (1.4677-1.4705) (CODEX STAN 33-1981). Results showed that, the differences in RI were non-significant and fall within the accepted range among the six EVOO country brands and agreed with international Codex Standard. The same manner was found for IV and SV which were used as indicator for identity of the oils and meet the limits of codex standards for virgin and refined olive oil (Table 1).

The free acidity showed that Spanish EVOO brand had the lowest value (0.25%) among the six EVOO country brands under the present study. The highest value was recorded in Egyptian EVOO brand (0.49%) followed by Tunisian EVOO brand (0.43%). On the other hand, PV attained the highest value in Egyptian EVOO brand (6.2) while, the lowest was in EVOO Spanish brand (1.9) in line with oxidative stability The values of FFA% and PV for the six EVOO country brands were felled within the limits of IOC Standard, 2016 for EVOO category . K232 and K270 which are mainly refer to the conjugated dienes and trienes upon oxidation of double bond and also of the presence of carbonylic compounds (second oxidation products). Table 1 shows highly significant differences in K232, K270 of different EVOO country brands. EVOO obtained from Egyptian brand had the highest values for K232 and K270 (4.48 and 0.41, respectively). On the other hand EVOO from Spanish brand showed the lowest values (1.88 and 0.14, respectively) followed by EVOO Italian brand at the same wavelengths. There were no significant differences for results of ΔK and they agree with the limits of EVOO.

Table 1: Physical and Chemical properties of different types of virgin olive oil

Characteristics	EVOO brands						LSD	EVOO IOC Standard 2016
	Spain	Italy	Greece	Syria	Tunisia	Egypt		
Free acidity (as oleic acid %)	$0.25^{b}\pm$ 0.5	$0.31^{b}\pm$ 0.01	$0.28^{b}\pm$ 0.08	$0.27^{b}\pm$ 0.09	$0.43^{a}\pm$ 0.08	$0.49^{a}\pm$ 0.04	0.09965	≤0.8
Peroxide value (meq/kg oil)	$1.9^{d}\pm$ 0.40	$2.2^{cd}\pm$ 0.70	$3.6^{bc}\pm$ 1.10	$4.8^{ab}\pm$ 1.30	$3.7^{b}\pm$ 0.70	$6.2^{a}\pm$ 1.20	$6.2^{a}\pm$ 1.20	≤20
K232	$1.886^{f}\pm$ 0.186	$2.228^{e}\pm$ 0.128	$2.957^{c}\pm$ 0.257	$2.556^{d}\pm$ 0.206	$4.306^{b}\pm$ 0.206	$4.488^{a}\pm$ 0.188	0.08136	≤2.5
K270	$0.143^{d}\pm$ 0.01 5	$0.224^{c}\pm$ 0.024	$0.274^{bc}\pm$ 0.074	$0.311^{b}\pm$ 0.061	$0.402^{a}\pm$ 0.102	$0.412^{a}\pm$ 0.102	0.05753	≤0.22
Δ K	$0.003^{a}\pm$ 0.001	$0.004^{a}\pm$ 0.002	$0.006^{a}\pm$ 0.001	$0.010^{a}\pm$ 0.005	$0.009^{a}\pm$ 0.002	0.009± 0.003	0.01819	≤0.01
Iodine value (Hanus)	$81.45^{b}\pm$ 1.45	$87.19^{a}\pm$ 2.19	$86.47^{a}\pm$ 1.47	$82.68^{b}\pm$ 2.68	$81.87^{b}\pm$ 1.37	$88.36^{a}\pm$ 3.36	3.588	75- 94*
Saponification value	$186^{b}\pm$ 2.0	$188^{b}\pm$ 3.0	$188^{b}\pm$ 4.0	$189^{b}\pm$ 2.0	$189^{b}\pm$ 6.0	$196^{a}\pm$ 4.0	5.448	184 – 196*
Refractive Index	$1.4677^{a}\pm$ 0.01	$1.4682^{a}\pm$ 0.01	$1.4680^{a}\pm$ 0.01	$1.4684^{a}\pm$ 0.01	$1.4698^{a}\pm$ 0.01	$1.4704^{a}\pm$ 0.01	0.01819	1.4677-1.4705*
Induction period (hours)	24.5^{a} ±0.5	$24.0^{ab}\pm$ 1.0	$24.0^{ab}\pm$ 0.5	$23.5^{ab}\pm$ 1.0	$23.0^{bc}\pm$ 1.0	$22.0^{c}\pm$ 0.5	1.314	
Oil grade	Extra	Extra	Ordinary	Ordinary	Ordinary	Ordinary		

- Each value represents the mean ± SD.

-The mean value with different superscript alphabets in a column indicate significant differences ($p < 0.05$) using LSD test.

**CODEX STAN 33-1981 Standard for Olive Oils And Olive Pomace Oils*

The Results of UV absorbance (K232 and K270) had high significant differences and revealed that four EVOO country brands (66.66% of samples) are exceeded the limits of EVOO according to IOC Standard, 2016 and not compliance with the declared oil grade on the label. Moreover, the Egyptian, Tunisian Syrian and Greece olive oil brads were considered ordinary virgin olive oil grade

based on the IOC standard (K232 ≤ 2.6 for virgin olive oil where, K270 ≤ 0.25 for virgin olive oil and ≤0.30 for ordinary olive oil). These mean that the four oil brands had poor quality and had high degree of oxidation. Also, it may be mixed with refined oil specially, for olive oil brands from Egypt, Tunisia and Syria.

With respect to oxidative stability Data in Table 1 shows that the EVOO Spanish brand had the highest oxidative stability (24.2 h) followed by EVOO Italian and Grecian brands. However, the lowest oxidative stability was found for EVOO Egyptian brand (22 h) followed by EVOO Tunisian and Syrian brands. Basuny *et al.,* (2008) had found correlation between stability and the bioactive components and the quality indices and their results indicated that the compound most related to oxidative stability were the phenolic compounds and pigments. The fatty acids of virgin olive oil are mainly monounsaturated (Table 2 and 3), these fact and the presence of tocopherol, carotenoids , pigments compounds make virgin olive oil more stable than other oils Gutierreez *et al.,* 2002.

It can conclude that physicochemical quality characteristics showed that , four of the six olive oil samples (66.6%) from different country brands were not compliance with EVOO limits of the IOC Standard, 2016 (trade standard applying for olive oil) as declared on the label "Extra virgin olive oil"

Fatty acid profile:

The fatty acids profile for EVOO country brands, total saturated fatty acids (SFA), polyunsaturated fatty acids (PUFA), monounsaturated fatty acids (MUFA), and MUFA/PUFA ratio are shown in Table (2). The results of fatty acid composition revealed that, palmitic acid (16: 0) varies between (11.30-15.32%) and the highest content of palmitic acid as saturated fatty acid was found in EVOO Syrian brand. Meanwhile, oleic (which has great importance because of their nutritional implication and effect on oxidative stability of oil) and linoleic acids (which is susceptible to oxidation) contents were the most useful and significant parameters for differentiating varieties, oleic acid (18: 1) varies between (65.44-78.60%) and the highest content of oleic acid as unsaturated fatty acid (78.60%) was found in EVOO Spanish brand. Whereas, the lowest percent was found in EVOO Syrian brand. On the other hand, the highest linoleic acid was found in Tunisian EVOO brand (12.07%). In addition, linolenic acid contents were found less than 1% in all EVOO samples brans. The best composition of fatty acids was found in Spanish EVOO brand as shown in table (2).

Table 2: Fatty acid composition of different types of virgin olive oil

Fatty Acids	EVOO brands						
	Spain	Italy	Greece	Syria	Tunisia	Egypt	IOC Standard,2016
C14:0	0.01	0.01	0.01	0.01	0.01	0.01	≤0.03
C16:0	11.30	13.42	12.29	15.32	14.40	13.30	7.5 - 20.0
C16:1	0.95	1.23	0.83	1.49	1.10	0.67	0.3 – 3.5
C17:0	0.04	0.07	0.05	0.09	0.07	0.05	≤0.40
C17: 1	0.08	0.10	0.08	0.13	0.10	0.10	≤0.60
C18:0	3.60	3.23	2.98	2.89	2.65	2.37	0.5 – 5.0
C18:1T	0.00	0.00	0.00	0.00	0.00	0.00	≤0.05
C18:1	78.60	71.66	74.67	65.44	67.86	70.12	55.0 –83.0
C18:2T	0.00	0.05	0.00	0.06	0.06	0.07	$C_{18:2t}+C_{18:3t} \leq 0.05$
C18:2	4.09	8.79	7.56	13	12.07	11.44	2.5 -21
C18:3	0.61	0.65	0.68	0.69	0.72	0.79	≤ 1.0
C20:0	0.38	0.43	0.42	0.49	0.47	0.46	≤ 0.60
C20:1	0.23	0.23	0.31	0.25	0.34	0.44	≤ 0.5
C22:0	0.09	0.10	0.10	0.13	0.12	0.14	≤ 0.20
SFA	15.42	17.26	15.85	18.93	17.72	16.33	
USFA	84.56	82.71	84.13	81.06	82.25	83.63	
MUFA	79.86	73.22	75.89	67.31	69.40	71.33	
PUFA	4.70	9.49	8.24	13.75	12.85	12.30	
MUFA/PUFA	16.99	7.71	9.21	4.89	5.40	5.80	

- Total saturated fatty acids (SFA), Total monounsaturated fatty acids (MUFA), Total poly- unsaturated fatty acids (PUFA)

The fatty acids composition of all six EVOO country brands olive oil was in the range of IOC trade standard (IOC, 2016).

The most important changes in the fatty acids were found in the exceeded values of C18:2T (Trans fatty acids) above the limits of IOC Standards, 2016 in EVOO of Syrian, Tunisian and Egyptian brands. The highest C18:2T value (0.07%) was found in EVOO Egyptian brand. The maximum limits of C18:2T+ C18:3T equal 0.05%.

Trans-fatty acids arise during refining of vegetable oils as well as during hydrogenation, or from attempts to eliminate the sterol fraction of seed oils with a fatty acid composition similar to that of olive oil (Firestone, 2005). These mean that Syrian, Tunisian and Egyptian olive oil samples may be mixed with refined oil specially, for olive oil brands from Egypt.

The result of fatty acid profile were emphasis the high result values of physicochemical properties for absorbency in UV at K270 for Syrian, Tunisian and Egyptian olive oil samples.

The importance of virgin olive oil is related to its high levels of monounsaturated fatty acids (mainly oleic acid) and poly phenole compounds (Mladenka Šarolić *et al*., 2014). The oxidative stability and health properties of virgin olive oil come from a prominent and well-balanced chemical composition (Guerfel *et al*., 2012). The high content of oleic acid in olive oil serves to slow down penetration of fatty acids into arterial walls (Mailer,2006). 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 levels (Hashempour *et al*., 2010).

Olive oil quality is related to the chemical composition of the oil, and its oxidative stability and sensory characteristics. These parameters are affected mainly by climatic conditions (Najaf *et al*., 2015) and (Fares *et al*., 2016). As indicated from the present study, significant differences among virgin olive oil samples of Mediterranean countries from different regions were observed ($p < 0.05$). Among them, Spain ,Italy and Greece orchards had the highest total unsaturated fatty acid content (84.56, 82.71 and 84.13 % respectively) with percentages of about 78.60, 71.61 and 74.67 % of oleic acid. Oleic acid values were significantly associated with mean temperature during oil accumulation (Rondanini *et al*., 2011) and (Mabroka *et al*., 2014).

The MUSFA/PUSFA ratio is frequently used as a stability parameter and, in previous studies; the cultivar with higher ratios were those with higher oxidative stability (Beltran, 2000). EVOO Spanish brand had the highest average values for (16.99) in accordance with their higher oxidative stability (24.5 h). Syrian EVOO brand had the lowest ratio 4.89 with considerable good oxidative stability 23.5 h (Table 1,2 and 3). This is due to the fact that oxidative stability is related not only to fatty-acid composition, but also to several other factors; pro- and/or anti-oxidant substances and concentration of natural antioxidants, such as polyphenols, in the oil (Ceci and Carelli., 2007).

Bioactive phenolic compound:

Phenolic compounds of olive oil samples are tabulated in Table (3). The results revealed that seventeen phenolic components were identified in EVOO country brands which represented Mediterranean countries. Chlorogenic acid, catechein and oleuropein were the predominant phenolic compounds in all olive oil samples brands. EVOO Spanish brand had the highest content of the abovementioned compounds and (4997, 361168.81 and 1161.75 µg/100g, respectively) followed by Italian and Tunisian EVOO brands for oleuropein content which were 1005.93 and 811.94 µg/100g However, EVOO Grecian brand had the lowest of oleuropein 387.55 µg/100g. phenolic compounds are consider potent natural antioxidant compounds. Oleuropein is the active ingredient or glucoside, found in green olives and olive leaves. Oleuropein and olive oil extracted from green olive. Oleuropein or olive oil is known for its multi-benefits for its properties as antioxidants, antifungal, anti- aging and anti-inflammatory (Bendini *et al*., (2007).

Identification of the phenolic compounds was based on comparisons of the chromatographic retention time and UV absorbance spectra of compounds in olive extracts with those of authentic standards. The beneficial effects that a diet rich in olive oil has on human health are well known. These benefits are mainly due to polyphenol content. The phenolic fraction of virgin olive oil (VOO) has generated much interest regarding its health-promoting properties. Subsequent studies (human, animal, *in vivo* and *in vitro*) have demonstrated that olive oil phenolics reduce the risk of chronic disease development, such as atherosclerosis, cardiovascular disease, and certain types of cancer

(Cicerale *et al.,*2008). European Food Safety Authority (EFSA), based on several scientific evidence (Covas *et al.,*2006 and De la Torre-Carbot *et al.,*2010), recently approved a health claim stating that the dietary intake of VOO polyphenols is able to prevent low density lipoprotein (LDL) oxidation (María-Isabel *et al.,* 2014). Hydroxytyrosol, and its derivatives, are the key compounds with such an activity, and to bear the claim olive oil should contain enough of them to provide 5 mg of these compounds daily. The main phenolic compounds in olive fruit are secoiridoid derivatives (oleuropein and ligstroside derivatives); olives also contain phenyl acids, phenyl alcohols, lignans and flavonoids (Tasioula-Margari, 2011). Several extraction procedures and analytical methods have been developed for separation and quantification of phenolic compounds from olive oil, which have led to ambiguous results that are difficult to compare (Tasioula -Margari and Tsabolatidou, 2015). Phenolic compounds have a strong antioxidant and a free radical scavenging ability (Baiano *et al.,* 2009). Moreover, their presence in olive oil contributes to the sensory characteristics, like its bitter, astringent and pungent taste (Diana and Maria 2015). As shown in Table 3, significant differences between locations were observed in phenolic contents.

Table 3: Phenolic compounds composition (µg/100g) of different types of EVOO brand

Type of phenolic compounds	EVOO brands					
	Spain	Italy	Greece	Syria	Tunisia	Egypt
Pyrogallol	404.58	793.76	678.83	408.45	1292.74	2484.41
Gallic	23.35	114.82	68.06	24.68	254.84	179.68
4-Amino-benzoic	385.85	1593.43	187.45	162.33	405.00	783.05
Catechein	1168.81	704.16	832.22	402.70	492.53	598.34
Chlorogenic	4997.36	780.12	417.99	333.29	566.78	4668.71
Epicatechein	67.13	136.43	70.82	49.61	104.04	172.81
Caffeine	369.64	196.17	176.72	230.78	173.02	1031.08
Vanillic	403.28	243.74	132.72	45.16	375.67	600.41
Caffeic	23.746	24.42	5.01	4.00	27.05	56.74
P-Coumaric	180.25	74.920	51.89	53.97	49.56	92.87
Ferulic	131.77	105.74	49.23	59.36	42.69	164.72
Oleuropein	1161.75	1005.93	811.94	680.59	387.55	532.84
Benzoic	937.78	162.20	223.85	1105.05	1392.11	756.95
Coumarin	91.282	92.80	69.04	86.40	124.17	171.73
3,4,5-methoxy-cinnamic	141.57	185.36	120.44	88.61	126.18	150.09
Salycilic	597.51	379.42	324.86	336.90	354.37	677.37
Cinnamic	101.30	64.90	6.00	48.56	6.44	22.69

Organoleptic characteristics:

Results in Table (4) shows the sensory attributes of different olive oil samples obtained from different olive oil country brands. Results in Table (4), show that, the median (Me) of the positive (fruity attribute) recorded a higher values in Spanish, Italian and EVOO according to sensory characteristic limits for EVOO of IOC Standard, 2016 (Fruity $\geq$ 0.00 and defects=0.00) number. Moreover, samples from Egypt, Tunisia and Syria were classified as ordinary virgin olive oil based on sensory analysis and limits of IOC Standard, 2106 (Median of defects; $3.5 \geq Me < 6$ and fruity = 0.00). Since, samples has noticeable rancidity defects as well as Egyptian olive oil sample had also musty and winey defect. However, olive oil sample from Syrian had winey defect beside rancid.

Grecian olive oil samples compared with other olive oil samples. These samples presented medium fruity attributes and consider a “Mild” oil except Italian oil which was somewhat bitter (Me=3). They classified as It can conclude that, sensory analysis is an essential criteria for the official control of extra virgin olive oil (EVOO) quality parallel with physicochemical quality criteria. The results and classification based on sensory analysis limits of IOC Standard,2016 showed that, only 3 samples (50 % of samples) resulted conform to the grade declared “ Extra Virgin Olive Oil” of the six olive oil samples from different country brands and the rest samples were not compliance with EVOO limits of the IOC Standard, 2016 (trade standard applying for olive oil)

Table 4: Sensory characteristics of EVOO samples brands

Attributes / Olive oil samples	Positive			Negative				Oil Category	EVOO IOC Standard
	Fruity	Bitter	Pungent	Fusty/ Muddy Sediment	Musty/Humid/ Earthy	Winey	Rancid		
Spain	$03.0^{a}\pm$ 0.20	$02.0^{b}\pm$ 0.10	$02.0^{a}\pm$ 0.20	0.0	$0.0^{b}\pm$ 0.0	$0.0^{b}\pm$ 0.0	$0.0^{d}\pm$ 0.0	Extra	Me of defects = 0.00 and Me of fruity › 0.00
Italy	$2.0^{b}\pm$ 0.10	$3.0^{a}\pm$ 0.20	$1.0^{b}\pm$ 0.15	0.0	$0.0^{b}\pm$ 0.0	$0.0^{b}\pm$ 0.0	$0.0^{d}\pm$ 0.0	Extra	
Greece	$0.5^{c}\pm$ 0.18	$0.5^{c}\pm$ 0.08	$0.0^{d}\pm$ 0.0	0.0	$0.0^{b}\pm$ 0.0	$0.0^{b}\pm$ 0.0	$0.0^{d}\pm$ 0.0	Extra	
Syria	$0.0^{d}\pm$ 0.0	$0.0^{d}\pm$ 0.0	$0.0^{d}\pm$ 0.0	0.0	$0.0^{b}\pm$ 0.0	$0.0^{b}\pm$ 0.0	$03^{c}\pm$ 0.30	Ordinary	
Tunisia	$0.5^{c}\pm$ 0.06	$0.5^{c}\pm$ 0.12	$0.5^{c}\pm$ 0.08	0.0	$0.0^{b}\pm$ 0.0	$1.0^{a}\pm$ 0.30	$3.5^{b}\pm$ 0.10	Ordinary	
Egypt	$0.0^{d}\pm$ 0.0	$0.5^{c}\pm$ 0.05	$0.0^{d}\pm$ 0.0	0.0	$1.0^{a}\pm$ 0.30	$1.0^{a}\pm$ 0.10	$3.7^{a}\pm$ 0.10	Ordinary	
L.S.D	0.2372	0.2228	0.1908	0.0	0.2228	0.2228	0.2698		

-Each value represents the mean ± SD.
-The mean value with different superscript alphabets in a column indicate significant differences ($p < 0.05$) using LSD test.
+ Category: according to Trade Standard Appling to Olive Oil and Olive Pomace Oils. COI/T.15/NC no.3/Rev. 4 November.

Conclusion

Olive oil is one of the oldest known vegetable oils mainly produced in the countries surrounding the Mediterranean Sea. It is a natural fruit juice, obtained from the fruit of tree Olea europaea L., with a unique composition and quality. Egyptian markets have many EVOO brands imported from Mediterranean countries, e.g. Spain, Italy and Greece etc. under different names and brands. The quality levels of the imported brands will differ and it has to examine to be meet the international standards due to ensure the quality and category as mentioned in the label. Results of this study show that sensory assessment, is an essential criteria for evaluation and classification of olive oil quality, for official control parallel with physicochemical quality criteria of "Extra Virgin Olive Oil" grade since, results of physicochemical analysis help in confirmed the negative sensory results and vice versa. Thus, there is strong relation between chemical tests and negative sensory results. In addition the study showed that about more than 66.66% of EVOO samples in Egyptian markets not compliance with the "Extra Virgin Olive Oil" grade mentioned on the label. Also, we recommended that sensory analysis should supported by GC analysis of volatile compound that are known to be result from lipid oxidation. Additional compositional analysis e.g. sterols, wax and ECN 42 as well should be carried out.

Finally, the present study revealed the quality characteristics of olive oil samples and the importance of virgin olive oil on health from the theraputic and nutritional (on human health and blood cholesterol level) point of view.

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