STUDY THE QUALITY PROPERTIES, SENSORY EVALUATION AND VOLATILE COMPONENTS OF OLIVE OIL IN SAUDI ARABIA

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Abstract. Saudi extra virgin olive oil is considered to be the best olive oil for its quality indices, minor components, and oxidative stability. The objective of this study was to analyze some quality indices (acid value, peroxide value and UV absorption K 232 and K 270 nm) of virgin olive oil of three varieties (Picual, Surani and Coratina) form Al–Jouf region, Kingdom of Saudi Arabia. Also, organoleptic tests, minor components (Phenolic content, orthodiphenol, α–tocopherol, bitter index, chlorophyll content and carotenoid content) and oxidative stability measured by Rancimat method at 100ºC ± 2ºC were determined. Fatty acid composition, phenolic fraction and volatile compounds of virgin olive oil samples were analyzed by gas chromatography (GC), high performance liquid chromatography (HPLC) and gas chromatography mass spectrum (GC–MS) systems. Results showed that significant differences between olive oil samples extracted from (Picual, Surani and Coratina) varieties.

Key words: Olive oil in Saudi Arabia, minor components, volatile compounds, organoleptic tests.

Introduction

Olive oil is a major agricultural commodity for the European Union with Ca. 75% of olive oil production coming from Spain, Italy and Greece [PRISTOURI et al., 2010]. Since 25 years ago olive oil production in Kingdom of Saudi Arabia in Al–Jouf by the successful present 99.6% for all olive grades.

There are more than 20 million olive trees in area and that more trees were being planted.

Al–Jouf Governorate had given top priority to cultivation and production of olives [FAO, 2010].

Virgin olive represents one of most important components of Mediterranean diet, and it is highly appreciated by consumers thanks to its health benefits and pleasant, particular flavor.

This product is obtained from fruit of olive trees (Olea europaea L.) using only mechanical techniques including crushing of the olive fruits, malaxing of resulting paste and separation of oily phase [YOUSSF et al., 2011].

All of these operations can affect quality, chemical composition and sensory characteristics of final product, and therefore, optimization of these extraction steps is necessary.

Being a very valuable product, it is important to evaluate its quality and authenticity by means of modern instrumental techniques and statistical evaluation of obtained data [ARVANITOYANNIS et al., 2005; ARVANITOYANNIS & VLACHOS, 2007].

One of primary causes of loss of olive oil quality is oxidation [ZANETIC et al., 2013]. Because of their role in oil stability there is a special interest in concentrations of antioxidant compounds, like polyphenols in virgin olive oil [DE STEFANO et al., 1999, BUTU et al., 2014]. A relationship between polyphenol content and oxidation stability has been reported for virgin olive oil [BASUNY & MOSTAFA, 2004, BASUNY et al., 2008 a].

The intensity of bitterness of olive oil has linked to presence of phenolics compounds derived from hydrolysis of oleuropein, which during oil extraction leads to its aglycon, named secoriridoid derivatives of phenols [GOMEZ RICO et al., 2008].

Minor compounds are of great importance in final composition of olive oil because they influence stability and overall acceptability as well as nutritional and health related properties of olive oil.
All varieties were collected by hand at mid. of October and November during crop season 2012. Only healthy fruits, without any kind of infection or physical damage were processed.

Reagents, solvents and standards:
All solvents in this study were purified and distilled before use. Folin–Ciocalteau reagent was obtained from Gerbsaure Chemical Co. Ltd., Germany. α–tocopherol and gallic acid standards were obtained from Koch Light Laboratories Ltd. England.

Oil extraction:
After harvest, fresh olives (1.5–2.0 kg) were washed and defoliated, crushed with mill and pressed using hydraulic press (Carver) press. Oil produced from each extraction was 200–250 (mL/kg), filtered and then transferred into dark glass bottles and stored in dark at 4°C until analysis.

Quality parameters:
Acidity, peroxide value and UV absorption characteristics, K232nm (conjugated dienes) and K270nm (conjugated trienes) were carried out following analytical methods described by A.O.A.C. (2005) [AOAC; 2005] .

Oil stability:
Oxidative stability was evaluated by Rancimat method [GUTIERREZ, 1989]

Stability was expressed as oxidation induction time (h), measured with Rancimat 679 apparatus (Metrohm Co., Herisou, Switzerland), using an oil sample of 5.00 g heated to 100°C ± 2°C with an air flow of 20 L/hr⁻¹.

Total phenolic content:
Total phenol content was calorimetrically quantified [RANALLI et al., 1999].

Phenolics compounds were isolated by triple extraction of a solution of oil (10 g) in hexane (20 mL) with 30 mL of a methanol–water mixture (60:40, v/v).

The Folin–Ciocalteau reagent was added to a suitable aliquot of combined extracts, and absorption of solution at 725 nm was measured. Orthodiphenol are measured colorimetrically at wave length of 370 nm after adding 5% (w/v) sodium molybdate in 50% methanol. Values are given as milligrams of gallic acid per kilogram of oil [GUTFINGER, 1987].
α–tocopherol content:
α–tocopherol was estimated by HPLC with direct injection of an oil–in–hexane solution: 1.5±0.01 g of oil dissolved in hexane to 10 mL [SALAS et al., 2000].

The volume of injection was 20 μL.
The mobile phase consisted of hexane/ethyl acetate (70:30) at a flow rate of 1 mL/min α–tocopherol was quantified by external standard method.

Results are given as milligrams of α–tocopherol per kilogram oil.

Pigment content:
Chlorophyll and carotenoid compounds (mg/kg) were determined at wave length of 670 nm and 472 nm, respectively, in cyclohexane using specific extinction values, by method of [MIGUEZ–MACSQUERA et al., 1991].

Bitter index:
Bitter index was evaluated by extraction of bitter compounds from olive oil samples. One gram ± 0.01 g oil sample was dissolved in 4 mL hexane and passed through C18 column (Se–Pack Cartridges, water, Milford MA), previously activated with methanol and washed with hexane (6 mL). After, 10mL of hexane was passed through to eliminate fat, and then retained compounds were with methanol/water (1:1) to 25 mL [GUTIERREZ et al., 1992]. The absorbance of extract was measured at 225nm against methanol/water (1:1) in a1cm cuvette.

Phenolic fraction:
Phenolic fraction was isolated by solid phase extraction and analyzed by reversed–phase HPLC using a diode array UV detector [MATEOS et al., 2001].

A Hewitt Packard series 1,100 liquid chromatographic system (Waldbronn, Germany) equipped with a diode array detector and a lichrosorb RP18 column (4.0 mm id C250 mm, particle size 5 mm, Merck, Darmstadt) was used.

Elution was performed at a flow rate of 1.0 mL/min with mobile phase of water/acetic acid (98:2 v/v, solvent A) and methanol/acetonitril (50:50, v/v, solvent B), starting with 5% B then increased to levels of 30% at 25 min, 40 % at 55 min, 52% at 40 min, 70% at 50 min, 100% at 55min, and kept as this stage for 5 min.

Quantification of phenolics compounds was carried out at wave length of 280 nm using P–hydroxybenzoic acid as an internal standard.

Fatty acids composition:
The fatty acid methyl esters were prepared as described in International Olive Oil Council [IOOC, 2009]. Methyl esters were prepared from olive oil, after saponification and analyzed by gas chromatography (Pye–Unicam model 104) equipped with flame ionization detector and glass coiled column (1.6 X 4 mm) supported on chromosorb W–AW 100–200 mesh, was used. The samples (μL) were injected into column using a Hamilton microsyringe.

The gas chromatographic conditions for isothermal analysis were: temperatures: the column 170°C detector 300°C and injector 250°C, flow rate: hydrogen 33 mL/min., nitrogen 30 mL/min and air 330 mL/min. Peak areas were measured using a spectra physics chronjet integrator according to method of [FARAG et al., 1984].

Organoleptic test:
The organoleptic test was determined for extracted oil according to International Olive Oil Council [IOOC, 2009]. 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 cover, samples were smelled and then tested by panelist to judge its flavor. The different attributes of oils were assessed and their intensities were evaluated as a mean value of panelists score.

Analysis of volatile compounds:
A–Extraction: About (100g) of olive oil was placed in a distillation flask with a little amount of distilled water. Steam was allowed to pass for four hours. The distillate was collected in an ice–cooled receiver, saturated with sodium chloride and extracted for several times with pure ether. The extract was kept at −10°C until analysis by GC–MS.
B–Identification: A GC Varian 240–MS equipped with a 1078 split/splitless injector coupled with a mass spectrometer Varian Satrurn 3 was used. A fused–silica
capillary column VF-5MS, 30 m X 0.25 mm i.d., 1 μm film thickness was employed. Helium was used as a mobile phase at a pressure of 15 psi with a flow rate of 2.2ml/min and a linear velocity of 30.7 cm/s at 35°C. The GC oven heating was started at 35°C. This temperature was maintained for 8 min. then increased to 45°C at rate of 1.5°C/min, increased to 150°C at a rate of 3°C/min. there increased to 180°C at rate of 4°C/min, and finally increased to 210°C at a rate 3.6°C/min. and maintained at temperature for 14.5°C/min: total time of analysis was 80 min. The injector temperature was maintained at 250°C. The temperature of transfer line was fixed at 220°C.

The mass spectrometer was operated in electron ionization mode at an ionization voltage of 70 eV in mass range of 10–350 amu at a scan rate of 1s/scan and a manifold temperature of 180°C. The GC–MS was operated through software Saturn GC–MS version 5.2 (Varian).

The volatile compounds were identified by comparison of their mass spectra and retention times with those of NIST–92 library.

Integration of all of chromatographic peaks was performed choosing three masses [SERPVILI et al., 2003; PUTNOKY et al., 2013; BUTNARIU, 2014].

**Statistical analysis:**
The results are reported as mean values. Data were compared on basis of standard deviation of mean values. In addition, Duncan’s multiple range tests were used to determine significant differences among data.

Statistical analysis was performed using Statistical 5.00 Package (Stat Soft 97 edition).

**Results and discussion**

**Quality indices:**

Table 1 shows quality indices of virgin olive oil samples from Picual, Surani and Coratina varieties in Al–Jouf City, Saudi Arabia. The data show that commercial qualitative parameters of virgin olive oil, such as free fatty acids, peroxide value and specific spectrophotometric absorptions in UV region. All values of analytical parameters still fell within “extra virgin” olive oil [EUROPEAN ECONOMIC COMMUNITY REGULATION, 2003].

This is not surprising because raw material was carefully selected, picked and processed. These parameters depend on cultivar quality of olive before their processing. It should be noted that lower values for these parameters will translate into a higher quality of oil. These results are in agreement with findings of other authors [ANGEROSA et al., 2001; RANALLI et al., 2003; BUTNARIU and GIUCHICI 2011, BAGIU et al., 2012].

**Table 1.**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Varieties</th>
<th>Picual</th>
<th>Surani</th>
<th>Coratina</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free fatty acids (% as oleic acid)</td>
<td>0.10±0.0001</td>
<td>0.12±0.0001</td>
<td>0.11±0.0001</td>
<td></td>
</tr>
<tr>
<td>Peroxide value (meq.o2/kg oil)</td>
<td>3.00±0.12</td>
<td>3.15±0.11</td>
<td>3.41±0.13</td>
<td></td>
</tr>
<tr>
<td>UV absorption</td>
<td>K232</td>
<td>0.21±0.07</td>
<td>0.15±0.09</td>
<td>0.31±0.01</td>
</tr>
<tr>
<td>Organoleptic tests</td>
<td>K270</td>
<td>0.05±0.001</td>
<td>0.09±0.001</td>
<td>0.11±0.001</td>
</tr>
<tr>
<td></td>
<td>7.00±0.25</td>
<td>6.90±0.30</td>
<td>6.85±0.23</td>
<td></td>
</tr>
</tbody>
</table>

Data are expressed mean ±SE. Each sample was analyzed three times.

Organoleptic test of olive oil samples extracted from Picual, Surani and Coratina varieties were evaluated by 10 panelists (Table 1).

From a sensory point of view all samples examined are belong to extra virgin olive oil grade. The direct observation of intensities of attributes detected by tasters showed that oils studied were mainly characterized by high intensities of bitter, pungent and fruity.

**Fatty acids composition:**

The importance of fatty acids is description and determination of...
adulteration. Fatty acids are main components of any edible oil. Table 2 shows that most abundant fatty acid composition in extra virgin olive oil are palmitic (C16:0), palmitoleic (C16:1), stearic (C18:0), oleic (C18:1), linoleic (C18:2), linolenic (C18:3) and Arachidic (C20:0) acids. Palmitic, stearic, oleic and linoleic acids were quantified as major ones. Palmitoleic, linolenic and arachidic acids were also determined but in smaller amounts, in all samples. The distribution of fatty acid composition covered normal range expected for olive oil [OUNI et al., 2011].

Pical and Surani olive oils highest percentage of oleic acid and lowest palmitic acid. Fatty acids composition has a relatively wide range due to genetic and environmental factors [MANAI et al., 2008; SALIMCAO & FARHAN, 2012].

Table 2.
Fatty acid composition of virgin olive oil extracted from Picual, Surani and Coratina varieties in Al–Jouf city, Saudi Arabia

<table>
<thead>
<tr>
<th>Fatty acids</th>
<th>Varieties</th>
<th>Picual</th>
<th>Surani</th>
<th>Coratina</th>
</tr>
</thead>
<tbody>
<tr>
<td>C16:0</td>
<td></td>
<td>18.00±1.11</td>
<td>17.50±1.01</td>
<td>15.30±0.98</td>
</tr>
<tr>
<td>C16:1</td>
<td></td>
<td>1.90±0.01</td>
<td>2.10±0.11</td>
<td>0.80±0.12</td>
</tr>
<tr>
<td>C18:0</td>
<td></td>
<td>4.10±0.15</td>
<td>5.20±0.20</td>
<td>3.10±0.13</td>
</tr>
<tr>
<td>C18:1</td>
<td></td>
<td>63.50±3.91</td>
<td>65.50±4.35</td>
<td>66.20±5.33</td>
</tr>
<tr>
<td>C18:2</td>
<td></td>
<td>12.50±0.90</td>
<td>11.30±0.95</td>
<td>13.89±1.00</td>
</tr>
<tr>
<td>C18:3</td>
<td></td>
<td>0.80±0.10</td>
<td>0.79±0.19</td>
<td>0.87±0.21</td>
</tr>
<tr>
<td>C20:0</td>
<td></td>
<td>0.20±0.001</td>
<td>0.41±0.01</td>
<td>0.44±0.07</td>
</tr>
</tbody>
</table>

Data are expressed mean ±SE. Each sample was analyzed three times.

Phenol, orthodiphenol, bitter index, α–tocopherol, chlorophyll and carotenoid content:

Olive oil is only vegetable oil that contains appreciable amounts of phenolic compounds acting as antioxidant substances and conferring to it a greater stability against oxidation [BENDINI et al., 2007; BUTNARID et al., 2006].

Table 3.
Total phenol, orthodiphenol, bitter index, α–tocopherol, pigments content and oxidative stability of virgin olive oil samples extracted from Picual, Surani and Coratina varieties in Al–Jouf city, Saudi Arabia

<table>
<thead>
<tr>
<th>Fatty acids</th>
<th>Varieties</th>
<th>Picual</th>
<th>Surani</th>
<th>Coratina</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phenol content (mg/ kg oil)</td>
<td></td>
<td>330.00±10.20</td>
<td>405.50±15.11</td>
<td>190.00±7.31</td>
</tr>
<tr>
<td>Orthodiphenol (mg/kg oil)</td>
<td></td>
<td>45.70±3.20</td>
<td>59.20±4.10</td>
<td>15.30±1.21</td>
</tr>
<tr>
<td>Bitter index (K225)</td>
<td></td>
<td>5.10±0.92</td>
<td>5.30±0.91</td>
<td>5.30±0.91</td>
</tr>
<tr>
<td>α–tocopherol (mg/kg oil)</td>
<td></td>
<td>288.00±8.50</td>
<td>295.40±9.10</td>
<td>194.30±7.93</td>
</tr>
<tr>
<td>Chlorophyll content (mg/kg oil)</td>
<td></td>
<td>10.30±0.93</td>
<td>15.30±1.20</td>
<td>16.50±1.33</td>
</tr>
<tr>
<td>Carotenoid content (mg/kg oil)</td>
<td></td>
<td>5.30±0.56</td>
<td>8.20±0.92</td>
<td>9.50±0.99</td>
</tr>
<tr>
<td>Oxidative stability (hrs)</td>
<td></td>
<td>29.50±1.93</td>
<td>30.00±2.01</td>
<td>19.20±1.45</td>
</tr>
</tbody>
</table>

Data are expressed mean ±SE. Each sample was analyzed three times.

Table 3 shows total phenols of oils from three different olive cultivars. Pical and Surani olive oils presented highest content (330.00 and 405.50 mg/kg) respectively, while lowest content was observed in Coratina olive oil.

Therefore, significant differences among various cultivars were observed with regard to total phenol contents and orthodiphenols (Table 3). These results are in agreement with findings of other authors [RANALLI et al., 2003; SERVILI et al., 2003].

Bitter index is one of characteristics attributes of virgin olive oil.

In our study bitter index (K225) was analyzed in oils from different cultivars (Pical, Surani and Coratina).

There were significant differences (P≥0.05) between olive oil samples from different cultivars, similar to that observed in oil phenol content (Table 3). Table 3 shows main components that are related to oil stability. The tocopherol content of virgin olive oil is important to protect lipids...
against autoxidation and thereby to increase its storage life and value as a whole some food. The range of α–tocopherol contents in olive oil from different cultivars is wide. There were significant differences (P≥0.05) in α–tocopherol content between cultivars.

Virgin olive oil from Coratina variety showed α–tocopherol content lower than those Picual and Surani varieties.

In addition to their antioxidant activities, these natural pigments are reasonable for oil color, considered as an oil quality parameter, and it is one of main factors that influence choice of consumers [GUTIERREZ et al., 1999]. Chlorophyll and carotenoid are positively correlated with oxidative stability (Table 3). Virgin olive oil from Picual showed least pigmentation. Significant differences were observed in total content of pigments between oils from different cultivars.

The production of highly pigmented oils should be of considerable interest for industry and can influence consumer’s choice. These results are in agreement with findings of other authors [STEFANOIDAKI et al., 2011].

Stability to oxidation is an important property of olive oil, which is improved by synergistic interactions between various antioxidants present in oil itself, and also depends on lipid composition.

Picual and Surani olive oils presented highest oxidative stability, while lowest value was recorded Coratina olive oil (Table 3). The reason could be positive correlation of oxidative stability with total phenol content [GUERFEL et al., 2009]. This result is in agreement with other reported investigation results [STEFANOIDAKI et al., 2011].

**Volatile compounds:**

Flavor is an important quality criterion for virgin olive oils. The identification of compounds causing flavor or off-flavor is therefore key quality control. Virgin olive oil has delicate and unique flavor [ANGROSA et al., 2000].

### Table 4. Volatile compounds (%) of virgin olive oil samples extracted from Picual, Surani and Coratina varieties in Al–Jouf city, Saudi Arabia

<table>
<thead>
<tr>
<th>Volatile compounds</th>
<th>Varieties</th>
<th>Picual</th>
<th>Surani</th>
<th>Coratina</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methyl–butanol</td>
<td></td>
<td>0.50±0.11</td>
<td>0.40±0.01</td>
<td>3.20±0.31</td>
</tr>
<tr>
<td>Pentan–3–one</td>
<td></td>
<td>5.10±0.82</td>
<td>5.70±0.33</td>
<td>5.30±0.83</td>
</tr>
<tr>
<td>2–methylbutanol</td>
<td></td>
<td>0.31±0.09</td>
<td>0.37±0.001</td>
<td>3.00±0.51</td>
</tr>
<tr>
<td>1–pentan–3–one</td>
<td></td>
<td>5.20±0.71</td>
<td>2.50±0.06</td>
<td>14.50±1.09</td>
</tr>
<tr>
<td>Butylacetate</td>
<td></td>
<td>5.80±0.92</td>
<td>7.20±0.93</td>
<td>5.50±0.94</td>
</tr>
<tr>
<td>Hexanal</td>
<td></td>
<td>3.20±0.73</td>
<td>0.90±0.19</td>
<td>1.20±0.001</td>
</tr>
<tr>
<td>E–2–methyl–2–butenal</td>
<td></td>
<td>2.90±0.09</td>
<td>12.50±0.98</td>
<td>7.10±0.93</td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td></td>
<td>4.88±0.11</td>
<td>1.80±0.13</td>
<td>14.50±1.33</td>
</tr>
<tr>
<td>2–methyl butyl acetate</td>
<td></td>
<td>5.92±0.32</td>
<td>2.30±0.11</td>
<td>1.40±0.001</td>
</tr>
<tr>
<td>z–3–hexenal</td>
<td></td>
<td>2.48±0.03</td>
<td>0.75±0.001</td>
<td>1.05±0.001</td>
</tr>
<tr>
<td>z–2–hexenal</td>
<td></td>
<td>2.49±0.01</td>
<td>9.50±0.94</td>
<td>0.43±0.001</td>
</tr>
<tr>
<td>E–2–hexenal</td>
<td></td>
<td>14.00±1.00</td>
<td>4.50±0.32</td>
<td>8.40±1.03</td>
</tr>
<tr>
<td>Trans–2–hexen–2–ol</td>
<td></td>
<td>3.01±0.45</td>
<td>4.50±0.41</td>
<td>5.50±0.79</td>
</tr>
<tr>
<td>Pentan–1–ol</td>
<td></td>
<td>2.82±0.09</td>
<td>1.10±0.02</td>
<td>3.40±0.68</td>
</tr>
<tr>
<td>3–methyl–2–butenylacetate</td>
<td></td>
<td>3.90±0.39</td>
<td>1.40±0.001</td>
<td>1.60±0.07</td>
</tr>
<tr>
<td>Hexylacetate</td>
<td></td>
<td>2.20±0.01</td>
<td>1.90±0.01</td>
<td>1.10±0.10</td>
</tr>
<tr>
<td>E–2–octenal</td>
<td></td>
<td>1.90±0.001</td>
<td>9.20±0.95</td>
<td>1.35±0.001</td>
</tr>
<tr>
<td>6–methyl–5–hepten–2–one</td>
<td></td>
<td>7.70±0.96</td>
<td>1.00±0.01</td>
<td>1.70±0.09</td>
</tr>
<tr>
<td>Hexan–1–ol</td>
<td></td>
<td>2.29±0.11</td>
<td>4.30±0.15</td>
<td>2.15±0.01</td>
</tr>
<tr>
<td>Z–2–hexen–1–ol</td>
<td></td>
<td>7.50±0.74</td>
<td>9.00±1.00</td>
<td>4.50±0.56</td>
</tr>
</tbody>
</table>

Data are expressed mean ±SE. Each sample was analyzed three times.

It is accepted that C₆ and C₅ metabolites are major contributors to green sensory perceptions, whereas polyphenolic fraction is considered to be mainly responsible for bitter and pungent percentage [GUTIERREZ ROSALES et al., 1992].

The volatile fraction of oils obtained from three different varieties was mainly formed of C₆ and C₅ compounds, produced from linolenic acid and linoleic acid through lipoxygenase pathways.

All identified volatiles are listed in Table 4.
Twenty-four compounds were characterized by GC-MS analysis.

The major constituents of volatile fraction of Picual oil are 1-penten-3-one, ethylbenzene, E-2-hexenal, E-2-methyl-2-butenal, trans-2-hexanal-1, butylacetate and pentan-3-one.

The volatile fraction of Surani olive oil was ethylbenzene, E-2-hexenal, E-2-octenol, E-2-methyl-2-butenal, butylacetate, pentan-3-one and Z-hexen-1-ol (Table 4).

The main constituents of that characterized volatile fraction of Coratina olive oil were E-2-hexenal, 6-methyl-5-hepten-3-one, Z-2-hexen-1-ol, butylacetate, 2-methyl-1-butyl acetate, 1-penten-3-one and ethylbenzenses (Table 4).

These results indicate that there were quantitative differences between volatile profiles of varieties analyzed (Picual, Surani and Coratina).

In general, results show that there were quantitative significant (p≥0.05) differences for volatile between all varieties [ANGROSA et al., 2004].

**Phenolic compounds:**

No qualitative differences were observed in HPLC phenolics fraction profile between virgin olive oils from different varieties (Picual, Surani and Coratina). However, significant quantitative differences (P≥0.05) were observed in a wide number of phenolic compounds (Table 5).

As a means explaining those differences, phenolic fraction was divided into four main groups (Simple phenol, secoiridoid derivatives, flavonoids, and latter part of chromatogram) in relation to simple phenols, higher concentration of hydroxytyrosol and tyrosol were observed in virgin olive oil from Picual variety, higher concentrations of secoiridoid derivatives were observed in virgin olive oil from Coratina variety. Low flavounoids levels represented by Gallic and elagic acid were observed in all olive oils analyzed. In spite of their low concentrations, flavounoids showed significant differences between olive oils from three different varieties.

**Table 5.**

<table>
<thead>
<tr>
<th>Phenolics compounds</th>
<th>Varieties</th>
<th>Picual</th>
<th>Surani</th>
<th>Coratina</th>
</tr>
</thead>
<tbody>
<tr>
<td>Querctin</td>
<td>0.50±0.00</td>
<td>0.01±0.00</td>
<td>0.01±0.00</td>
<td></td>
</tr>
<tr>
<td>Ferulic acid</td>
<td>3.19±0.31</td>
<td>3.05±0.19</td>
<td>2.09±0.09</td>
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</tr>
<tr>
<td>Cinamic acid</td>
<td>2.20±0.11</td>
<td>2.05±0.11</td>
<td>6.20±0.57</td>
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</tr>
<tr>
<td>Tyrosol</td>
<td>19.00±1.00</td>
<td>20.32±1.11</td>
<td>20.00±0.99</td>
<td></td>
</tr>
<tr>
<td>Hydroxytyrosol</td>
<td>28.30±1.92</td>
<td>27.50±1.61</td>
<td>26.50±1.37</td>
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<tr>
<td>Vanilic acid</td>
<td>7.00±0.81</td>
<td>3.30±0.45</td>
<td>6.15±0.58</td>
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<tr>
<td>p-hydroxybenzoic acid</td>
<td>17.00±0.93</td>
<td>17.12±0.86</td>
<td>16.50±0.94</td>
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</tr>
<tr>
<td>Chlorogenic acid</td>
<td>6.40±0.61</td>
<td>5.50±0.59</td>
<td>5.18±0.69</td>
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</tr>
<tr>
<td>Apigenin</td>
<td>4.55±0.19</td>
<td>6.19±0.71</td>
<td>6.28±0.85</td>
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<tr>
<td>Elagic acid</td>
<td>3.02±0.11</td>
<td>4.05±0.39</td>
<td>3.10±0.29</td>
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<tr>
<td>Gallic acid</td>
<td>4.11±0.23</td>
<td>4.75±0.41</td>
<td>6.00±0.78</td>
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</table>

Data are expressed mean ±SE. Each sample was analyzed three time.

**Conclusion**

Saudi extra virgin olive oil has good properties as it contains low acidity and peroxide values and high minor components and oleic acid.

Therefore, Saudi extra virgin olive oil is best choice for cooking, treatment and for many applications.

**Acknowledgment**

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**References**

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