Evaluation of Mandatory Testing
California Olive Oil
2018/19 Season

Submitted to the
Olive Oil Commission of California

August 2019

UC DAVIS
Olive Center
at the Robert Mondavi Institute
Evaluation of Mandatory Testing, California Olive Oil, 2018/19 Season

SUMMARY

The Olive Oil Commission of California (OOCC) contracted with the UC Davis Olive Center to analyze and report on 2018/19 data produced under the mandatory sampling and testing requirements of California olive oil standards.

The standards require the OOCC to collect five samples from lots chosen at random at each Handler and require the OOCC to send the samples for testing. Standards also require Handlers to separately sample and test every lot.

A total of 165 samples were collected and tested by the OOCC (53 samples) and 12 Handlers (112 samples). Handlers designated presumed grades of all lots prior to testing and samples were analyzed based on the quality tests specified in California standards. All but one of the 165 samples provided complete data for all required tests.

Our review of the quality testing data found that:

- 84 percent (139 samples) were from lots that Handlers had designated as Extra Virgin grade prior to testing. Test results confirmed that all 139 samples were Extra Virgin grade.
- 10 percent (17 samples) were from lots that Handlers had designated as Virgin grade. Test results confirmed 11 samples as Virgin grade, three samples tested as Crude grade, two samples tested as Extra Virgin grade and one sample had incomplete data.
- 6 percent (9 samples) were from lots that Handlers had designated as Crude grade or “second extraction.” Six of these samples were confirmed by testing as Crude grade, while one sample was tested as Extra Virgin grade and two samples were tested as Virgin grade.

Just over half of the OOCC samples (27 of 53 samples) were also analyzed for the purity tests specified in the standards. Our review of the purity testing data found that 22 percent (six of 27 samples) were outside of sterol parameters, although these same samples were graded as Extra Virgin based on quality tests.

The commission may wish to consider:

- addressing “second extraction” in California standards;
- ensuring that specific organoleptic defects are reported in Handler data;
- requiring the third-party sampling agency to submit complete information on sample variety and percentage; and
- recommending modifications to California olive oil standards so that sterol profile standards accommodate all olive oil produced in California.

INTRODUCTION

The Olive Oil Commission of California contracted with the UC Davis Olive Center to analyze the testing results for oils produced during the 2018/19 Season. The oils were sampled and tested in accordance with California olive oil standards\(^1\) which require annual sampling and testing of olive oil produced in California.

The standards require the OOCC to conduct sampling and testing under the direction of the California Department of Food and Agriculture (CDFA) or by an approved independent third party. The sampling party must take five samples at random from each Handler\(^2\) following the sampling procedures and protocols of the International

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1 See California Department of Food and Agriculture, “2017-2018 Grade and Labeling Standards for Olive Oil, Refined-Olive Oil and Olive-Pomace Oil”, effective September 1, 2017 and continuing through June 30, 2018 unless amended or terminated.
2 “Handler” is defined by Section 5.13 of the California standards as “a person who engages, in this state, in the operation of marketing olive oil that he or she has produced, or purchased or acquired from an olive producer, or that he or she is marketing on behalf of an olive producer, whether as an owner, agent, employee, broker, or otherwise.”
Organization for Standardization (ISO)\(^3\) and Appendix A\(^4\) in the California olive oil standards, and send the samples to an accredited laboratory for analysis.

Standards also require the Commission to direct the sampling party to randomly select a number of samples for testing based on the purity parameters indicated in the Standards at an analytical laboratory designated by the OOCC. California standards do not allow lots that fail purity testing to be sold as olive oil, refined olive oil or olive-pomace oil.\(^5\)

In addition to the sampling and testing conducted by the OOCC, the standards require each Handler to sample, test, and grade each lot by a certified laboratory chosen by the Handler, including the Handler’s own laboratory, following an official testing method described in California olive oil standards. Grading is based on the quality standards summarized in Table 1 and described in the Appendix.

<table>
<thead>
<tr>
<th>Test</th>
<th>Extra Virgin</th>
<th>Virgin</th>
<th>Crude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free Fatty Acidity (FFA) %m/m expressed as oleic acid</td>
<td>≤0.5</td>
<td>≤1.0</td>
<td>&gt;1.0</td>
</tr>
<tr>
<td>Peroxide Value (PV) meq. O(_2)/kg oil</td>
<td>≤15.0</td>
<td>≤20.0</td>
<td>&gt;20.0</td>
</tr>
<tr>
<td>(K_{232}) Ultraviolet Absorbance (UV) Kthers</td>
<td>≤2.40</td>
<td>≤2.60</td>
<td>&gt;2.60</td>
</tr>
<tr>
<td>(K_{270}) Ultraviolet Absorbance (UV) Kthers</td>
<td>≤0.22</td>
<td>≤0.25</td>
<td>&gt;0.25</td>
</tr>
<tr>
<td>ΔK Ultraviolet Absorbance (UV) Kthers</td>
<td>≤/0.01/</td>
<td>≤/0.01/</td>
<td>≤/0.01/</td>
</tr>
<tr>
<td>Moisture and Volatile Matter (MOI) %</td>
<td>≤0.2</td>
<td>≤0.2</td>
<td>≤0.3</td>
</tr>
<tr>
<td>Insoluble Impurities (INI) %m/m</td>
<td>≤0.1</td>
<td>≤0.1</td>
<td>≤0.2</td>
</tr>
<tr>
<td>Pyropheophytin a (PPPs) %</td>
<td>≤17</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>1,2–Diacylglycerols (DAGs) %</td>
<td>≥35</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Organoleptic Median of Defects (MeD)</td>
<td>0</td>
<td>&gt;0.0</td>
<td>≤2.5</td>
</tr>
<tr>
<td>Organoleptic Median of Fruity (MeF)</td>
<td>&gt;0.0</td>
<td>&gt;2.5</td>
<td>N/A</td>
</tr>
</tbody>
</table>

**SAMPLE INFORMATION**

Handlers designated the presumed grade of lots prior to sampling and testing. A total of 165 samples (which included two samples from a voluntary Handler\(^6\)) were tested in the 2018/19 Season: 53 samples (32 percent) were collected by the OOCC and 112 (68 percent) were collected by 12 Handlers. Based on lot codes provided by the OOCC, 52 of 53 OOCC samples (98 percent) were from the same lots tested by the Handler.

OOCC samples were collected by CDFA officials from Handler lots in January and February 2019. CDFA sent the samples to Eurofins Central Analytical Laboratories (New Orleans, Louisiana) for chemistry testing and Eurofins contracted with Applied Sensory (Fairfield, California) for organoleptic analysis. Samples that were found to be outside the organoleptic standard for Extra Virgin grade were retested by the Applied Sensory panel until the same grading was obtained twice.

\(^4\) Appendix A: Sampling, Testing and Grading Methodology for Olive Oil, Refined-Olive Oil and Olive-Pomace Oil.
\(^5\) Section 6.2 in Appendix A: Sampling, Testing and Grading Methodology for Olive Oil, Refined-Olive Oil and Olive-Pomace Oil.
\(^6\) https://www.oliveoilcommission.org/olive-oil-commission-california-makes-voluntary-participation-accessible/
Each Handler sent samples to a certified laboratory and sensory panel of their choice. All Handlers provided sampling dates, which ranged from October 23, 2018 to February 18, 2019 and all but two Handlers also provided harvest dates for the samples.

Table 2 shows the variety and variety percentage of the samples. Overall, 55 percent (91 of 165 samples) were single-variety, 42 percent (69 samples) were blends and 3 percent (5 samples) were unspecified or vaguely defined.

<table>
<thead>
<tr>
<th>Variety</th>
<th>OOCC Samples</th>
<th>Handler Samples</th>
<th>Total Samples (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arbequina</td>
<td>7</td>
<td>20</td>
<td>27 (16.4%)</td>
</tr>
<tr>
<td>Arbosana</td>
<td>6</td>
<td>17</td>
<td>23 (13.9%)</td>
</tr>
<tr>
<td>Ascolano</td>
<td>1</td>
<td>1</td>
<td>2 (1.2%)</td>
</tr>
<tr>
<td>Coratina</td>
<td>3</td>
<td>3</td>
<td>6 (3.6%)</td>
</tr>
<tr>
<td>Frantoio</td>
<td>1</td>
<td>2</td>
<td>3 (1.8%)</td>
</tr>
<tr>
<td>Hojiblanca</td>
<td>1</td>
<td>1</td>
<td>2 (1.2%)</td>
</tr>
<tr>
<td>Koroneiki</td>
<td>5</td>
<td>7</td>
<td>12 (7.3%)</td>
</tr>
<tr>
<td>Manzanillo</td>
<td>0</td>
<td>2</td>
<td>2 (1.2%)</td>
</tr>
<tr>
<td>Mission</td>
<td>1</td>
<td>2</td>
<td>3 (1.8%)</td>
</tr>
<tr>
<td>Picual</td>
<td>2</td>
<td>3</td>
<td>5 (3%)</td>
</tr>
<tr>
<td>Sevillano</td>
<td>1</td>
<td>2</td>
<td>3 (1.8%)</td>
</tr>
<tr>
<td>Taggiasca</td>
<td>1</td>
<td>2</td>
<td>3 (1.8%)</td>
</tr>
<tr>
<td>Blends</td>
<td>20</td>
<td>49</td>
<td>69 (41.8%)</td>
</tr>
<tr>
<td>Unspecified or Vague</td>
<td>4</td>
<td>1</td>
<td>5 (3%)</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>53</strong></td>
<td><strong>112</strong></td>
<td><strong>165 (100%)</strong></td>
</tr>
</tbody>
</table>

Sixty-eight percent of the samples were produced from varieties that grow in the super-high-density (SHD) system, which reflects the dominance of this system in California olive orchard; 23 percent were from varieties that grow in lower-density planting systems; 7 percent were from blends from these two systems and 2 percent were unspecified.

There was a significant improvement this year in Handlers reporting all data required by California standards, with only one sample (less than one percent) was missing organoleptic data while in the previous season 23 percent of samples were missing test data.

**RESULTS FOR QUALITY TESTS**

As previously noted, Handlers reported the presumed grades of lots to the OOCC prior to sample collection and testing. Out of 165 samples, 84 percent (139 samples) were designated as Extra Virgin grade, 10 percent (17 samples) as Virgin grade, and 5 percent (9 samples) as Crude or “second extraction” (past studies have shown that all previous samples designated by Handlers as “second extraction” have tested at Crude grade.) As summarized in Table 3, our review of the quality testing data found that:

- 100 percent of 139 samples that were designated by Handlers as Extra Virgin grade were confirmed by testing as Extra Virgin grade.
- 65 percent (11 of 17 samples) that were designated by Handlers as Virgin grade were confirmed by testing as Virgin grade, with three samples testing at Crude grade, two samples testing at Extra Virgin grade and one sample had incomplete data.
- 67 percent (6 of 9 samples) that were designated by Handlers as Crude grade or “second extraction” were confirmed by testing as Crude grade, with two samples tested at Virgin grade and one sample tested at Extra Virgin grade.
Table 3. Overview of samples by grade

<table>
<thead>
<tr>
<th></th>
<th>Handler</th>
<th>OOCC</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total samples collected</strong></td>
<td>112</td>
<td>53</td>
<td>165</td>
</tr>
<tr>
<td><strong>Total samples that met Extra Virgin grade</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Samples designated as Extra Virgin grade prior to testing by Handlers</td>
<td>92</td>
<td>47</td>
<td>139</td>
</tr>
<tr>
<td>Samples confirmed as Extra Virgin grade by testing</td>
<td>92</td>
<td>47</td>
<td>139</td>
</tr>
<tr>
<td><strong>Total samples that met Virgin grade</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Samples designated as Virgin grade prior to testing by Handlers</td>
<td>15</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>Samples confirmed as Virgin grade by testing</td>
<td>10</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td><strong>Total samples that met Crude grade</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Samples designated as Crude grade or “second extraction” prior to testing by Handlers</td>
<td>5</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Samples confirmed as Crude grade by testing</td>
<td>4</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>* One sample designated as Virgin grade did not provide complete data.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4 provides the details of the 23 samples where tests showed grades below Extra Virgin. In summary Table 4 shows that:

- 82 percent (19 of 23 samples) confirmed the presumed grade designated by Handlers (if “second extraction” is categorized with Crude grade),
- 13 percent (3 of 23 samples) were designated by the Handler to be Virgin grade but were tested at Crude grade and
- 4 percent (1 of 23 samples) had incomplete data and therefore testing could not determine the grade.

Sixteen of the 23 samples had organoleptic defects, but six of the samples did not specify which defect. It is unclear whether this information was not provided to the Handler by the sensory panel or whether the Handler omitted this data when reporting to the commission. Knowing the type of defect could indicate useful information to the Handler and the commission as to the potential cause of the defect. The commission does not require Handlers to provide organoleptic testing for lots that the Handler presumes to be Crude grade if chemical tests are performed7.

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7 Section 4.1.3: Sampling, Testing and Grading Methodology for Olive Oil, Refined-Olive Oil and Olive-Pomace Oil.
Table 4. Summary of quality testing results indicating lower grade samples (23 of 165 samples)

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Sampling Party</th>
<th>FFA</th>
<th>PV</th>
<th>UV K270</th>
<th>MOI</th>
<th>Organoleptic</th>
<th>Handler Presumed Grade</th>
<th>Tested Grade</th>
<th>Possible Cause(s) of Lower Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA Extra Virgin Standard</td>
<td>Handler</td>
<td>≤0.5</td>
<td>≤15.0</td>
<td>≤0.22</td>
<td>≤0.2</td>
<td>MeD=0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B2018000082440 (A5)</td>
<td>Handler</td>
<td>0.7</td>
<td>0.34</td>
<td>0.44</td>
<td>1.3 R</td>
<td>2.1 R, 0.9 F/MS</td>
<td>Second Extraction</td>
<td>Crude</td>
<td>1, 2</td>
</tr>
<tr>
<td>10141 (C3)</td>
<td>Handler</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2.4 R</td>
<td>-</td>
<td>Virgin</td>
<td>Virgin</td>
<td>2</td>
</tr>
<tr>
<td>US 19/008 (Q3)</td>
<td>Handler</td>
<td>0.7</td>
<td>0.32</td>
<td>0.39</td>
<td>1.0 R</td>
<td>-</td>
<td>Virgin</td>
<td>Virgin</td>
<td>1, 2</td>
</tr>
<tr>
<td>3997</td>
<td>Handler</td>
<td>0.9</td>
<td>0.26</td>
<td>0.34</td>
<td>1.0 R</td>
<td>-</td>
<td>Virgin</td>
<td>Virgin</td>
<td>1</td>
</tr>
<tr>
<td>20180006</td>
<td>Handler</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.0 R</td>
<td>1.6 R, 1.2 F/MS</td>
<td>Virgin</td>
<td>Virgin</td>
<td>1</td>
</tr>
<tr>
<td>20180008</td>
<td>Handler</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4.0 (defect not specified)</td>
<td>-</td>
<td>Virgin</td>
<td>Virgin</td>
<td>4</td>
</tr>
<tr>
<td>20180009</td>
<td>Handler</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.75 (defect not specified)</td>
<td>-</td>
<td>Virgin</td>
<td>Virgin</td>
<td>4</td>
</tr>
<tr>
<td>20180011</td>
<td>Handler</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4 (defect not specified)</td>
<td>-</td>
<td>Virgin</td>
<td>Virgin</td>
<td>4</td>
</tr>
<tr>
<td>20180016</td>
<td>Handler</td>
<td>0.6</td>
<td>0.26</td>
<td>0.34</td>
<td>2.5 (defect not specified)</td>
<td>-</td>
<td>Virgin</td>
<td>Virgin</td>
<td>4</td>
</tr>
<tr>
<td>B2018000082106</td>
<td>Handler</td>
<td>0.9</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Virgin</td>
<td>Virgin</td>
<td>1</td>
</tr>
<tr>
<td>B2018000082126</td>
<td>Handler</td>
<td>0.7</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Virgin</td>
<td>Virgin</td>
<td>1</td>
</tr>
<tr>
<td>B2018000082558</td>
<td>Handler</td>
<td>-</td>
<td>-</td>
<td>0.26</td>
<td>-</td>
<td>-</td>
<td>Second Extraction</td>
<td>Crude</td>
<td>2</td>
</tr>
<tr>
<td>CR 3108</td>
<td>Handler</td>
<td>1.7</td>
<td>0.26</td>
<td>0.44</td>
<td>-</td>
<td>-</td>
<td>Not required</td>
<td>Crude</td>
<td>4</td>
</tr>
<tr>
<td>F18013</td>
<td>Handler</td>
<td>0.6</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Virgin</td>
<td>Virgin</td>
<td>1</td>
</tr>
<tr>
<td>F18016</td>
<td>Handler</td>
<td>0.6</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Virgin</td>
<td>Virgin</td>
<td>1</td>
</tr>
<tr>
<td>F18022</td>
<td>Handler</td>
<td>0.6</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Virgin</td>
<td>Virgin</td>
<td>1</td>
</tr>
<tr>
<td>US 18/436</td>
<td>Handler</td>
<td>0.7</td>
<td>-</td>
<td>-</td>
<td>1.0 M</td>
<td>-</td>
<td>Virgin</td>
<td>Virgin</td>
<td>1, 3</td>
</tr>
<tr>
<td>VV2568</td>
<td>Handler</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Not submitted</td>
<td>Virgin</td>
<td>Incomplete</td>
</tr>
</tbody>
</table>

Data within the standards: *N/A* Data not available; *Fusty; FM* Fusty/Muddy Sediment; *Musty; M* Musty; *Rancid; R* Olives had fermented or undergone hydrolysis prior to processing or oil was stored on sediment for extended period (indicated by elevated FFA, MOI and F or F/MS defect); *2* Oil had become oxidized (indicated by elevated PV, K270 and R defect); *3* Olives had experienced low temperatures and high humidity which promote mold growth, mainly of the Aspergillus and Penicillium genera (indicated by elevated FFA and M defect); *4* Organoleptic defect not identified/specified so cause of defect undeterminable.

Table 5 provides a summary of grading agreement over the past five seasons. The 2018/19 Season had a grading consistency of 100 percent (52 of 52 lots) when the same lot was tested by both the Handler and the OOCC, an improvement upon the previous season’s 92 percent rate.

Table 5. Olive oil grading consistency for same lots from 2014/15 to 2018/19 harvest seasons

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of lots tested by both the Handler and the OOCC</td>
<td>26</td>
<td>41</td>
<td>51</td>
<td>64</td>
<td>52</td>
</tr>
<tr>
<td>Number of samples in grading agreement</td>
<td>22</td>
<td>39</td>
<td>51</td>
<td>59</td>
<td>52</td>
</tr>
<tr>
<td>Percentage of grading agreement (%)</td>
<td>85</td>
<td>95</td>
<td>100</td>
<td>92</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 6 summarizes the average values of chemical quality data for Extra Virgin samples over the past five seasons. The table shows that the 2018/19 season had the lowest average peroxide value of the past five seasons, a favorable indicator of low levels of initial oxidation as peroxide value typically increases rapidly at the first month of storage. On the other hand, free fatty acidity had the highest average value compared to past seasons at 0.3, and DAGs had the lowest level since the 2014/15 season at 86. The decline in free fatty acidity and DAGs may reflect an excess of material-other-than-olives in the harvest bins requiring longer sorting and processing times for many growers. Organoleptic testing showed that the median of fruitiness was equal to last year’s average of 3.6, which is below the levels of the three prior seasons.

Table 6. Summary of quality testing results for Extra Virgin samples from 2014/15 to 2018/19 harvest seasons

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Free Fatty Acidity (≤0.5)</td>
<td>0.2±0.1</td>
<td>0.2±0.1</td>
<td>0.2±0.1</td>
<td>0.1±0.1</td>
<td>0.3±0.1</td>
</tr>
<tr>
<td>Peroxide Value (≤15.0)</td>
<td>7.3±2.8</td>
<td>5.9±2.9</td>
<td>5.5±2.5</td>
<td>5.3±2.6</td>
<td>4.3±1.6</td>
</tr>
<tr>
<td>UV K232 (≤2.40)</td>
<td>1.69±0.25</td>
<td>1.77±0.21</td>
<td>1.78±0.22</td>
<td>1.67±0.2</td>
<td>1.71±0.19</td>
</tr>
<tr>
<td>UV K270 (≤0.22)</td>
<td>0.12±0.03</td>
<td>0.12±0.03</td>
<td>0.13±0.03</td>
<td>0.12±0.03</td>
<td>0.12±0.03</td>
</tr>
<tr>
<td>Moisture and Volatile Matter (≤0.2)</td>
<td>&lt;0.003</td>
<td>&lt;0.003</td>
<td>0.00±0.00</td>
<td>0.00±0.00</td>
<td>0.00±0.00</td>
</tr>
<tr>
<td>Insoluble Impurities (≤0.1)</td>
<td>0.0±0.00</td>
<td>0.0±0.00</td>
<td>0.0±0.00</td>
<td>0.0±0.00</td>
<td>0.0±0.00</td>
</tr>
<tr>
<td>Pyropheophytins (≤8.6)</td>
<td>2±1</td>
<td>2±1</td>
<td>2±1</td>
<td>1±1</td>
<td>1±1</td>
</tr>
<tr>
<td>1,2-Diacylglycerols (≥35)</td>
<td>82±10</td>
<td>88±6</td>
<td>89±7</td>
<td>91±6</td>
<td>86±6</td>
</tr>
<tr>
<td>Organoleptic (MeF&gt;0)</td>
<td>4.2±0.7</td>
<td>4.4±0.7</td>
<td>4.6±0.8</td>
<td>3.6±0.7</td>
<td>3.6±0.6</td>
</tr>
</tbody>
</table>

RESULTS FOR PURITY TESTS

The OCCC sent 27 of the 53 samples that were collected by CDFA officials to Eurofins Central Analytical Laboratories to conduct purity tests required by California standards. Testing results indicated that 78 percent (21 of 27 samples) were within purity parameters.

Of the 22 percent (six of 53 samples) that were outside purity parameters, all were sourced from the Central Valley and confirmed by quality testing as Extra Virgin grade. Each of the six samples was outside one or more sterol parameters:

- two Koroneiki samples, one from Madera County and the other from Fresno County, slightly exceeded the standard of campesterol with values of 4.6 (California standard ≤ 4.5);
- one Frantoio sample from Tehama County had a delta-7-stigmasterol value of 0.66, which was outside the limit of ≤ 0.5);
- one Coratina sample from Tehama County had a level of total sterols of 686, below the minimum of 1000;
- two blend samples from the Central Valley comprised of SHD varieties had extremely high values of delta-7-stigmasterol at 9.2 and 14.4, respectively (California standard ≤ 0.5), and low apparent β-sitosterol values at 86.1 and 81.2, respectively (California standard ≥ 93.0).

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9 Given the abnormally high values of delta-7-stigmasterol of these two samples from the Central Valley region, the Olive Center recommends the Commission to confirm the data accuracy with the third-party laboratory.
Sterols, similar to fatty acids, can be affected by factors unrelated to the authenticity of an oil, such as geographical origin, climate and altitude, cultivar and harvest period, irrigation strategies, and processing techniques. Purity data collected by the OOCC from 2015/16 to 2018/19 shows that nine percent (11 of 119 samples) did not meet at least one purity parameter in California standards. The commission may want to consider modifications to California olive oil purity standards so that the standards accommodate all olive oil produced in California.

CONCLUSIONS AND RECOMMENDATIONS

- Handlers performed well in reporting complete data and in determining presumed grades prior to testing. All 139 samples designated by Handlers as Extra Virgin grade were confirmed by testing.
- Three samples were designated by a Handlers as “second extraction,” which is not a designation discussed in California standards although past studies have shown that all previous samples designated by Handlers as “second extraction” have tested at Crude grade. The OOCC may want to consider how to address “second extraction” in California standards.
- Some Handlers did not report the type of organoleptic defect for lower-grade samples. It is unclear whether this information was not provided by the sensory panel or whether the Handler omitted this data when reporting to the commission. Knowing the type of defect could indicate useful information to the Handler and the commission as to the potential cause of the defect. The commission may want to address why information on specific defects is missing from some samples.
- Four out of 53 OOCC samples (eight percent) had incomplete information on variety and variety percentage. The OOCC may want to ensure the approved third-party sampling agency to submit complete information on sample variety and percentage.
- Twenty two percent of samples (six of 27 samples) did not meet purity parameters for sterol profile, even though the samples were confirmed in quality testing to be Extra Virgin grade. The commission may want to consider modifications to California olive oil standards so that sterol profile standards accommodate all olive oil produced in California.

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## APPENDIX

### Quality tests in California olive oil standards

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>DETERMINATION</th>
<th>INDICATOR</th>
<th>METHODOLOGY</th>
<th>CA EXTRA VIRGIN STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free Fatty Acids (FFA)</td>
<td>Free fatty acids are formed by the hydrolysis of the triacylglycerols during extraction, processing and storage.</td>
<td>An elevated level of free fatty acid indicates hydrolyzed fruits and/or poor quality oil made from unsound fruit, improperly processed or stored oil.</td>
<td>Analytical Titration</td>
<td>≤ 0.5 % as oleic acid</td>
</tr>
<tr>
<td>Peroxide Value (PV)</td>
<td>Peroxides are primary oxidation products that are formed when oils are exposed to oxygen, producing undesirable flavors and odors.</td>
<td>An elevated level of peroxides indicates oxidized and/or poor quality oil.</td>
<td>Analytical Titration</td>
<td>≤ 15 meq O₂/kg oil</td>
</tr>
<tr>
<td>Ultraviolet absorbance (UV)</td>
<td>Conjugated double bonds are formed from natural non-conjugated unsaturation in oils upon oxidation. The K232 measures primary oxidation products and K270 measures secondary oxidation products.</td>
<td>An elevated level of UV absorbance indicates oxidized and/or poor quality oil.</td>
<td>UV spectrophotometry</td>
<td>K232: ≤ 2.40 K 1% 1cm⁻¹; K270: ≤ 0.22 K 1% 1cm⁻¹; ΔK: ≤ 0.01 K 1% 1cm</td>
</tr>
<tr>
<td>1,2-Diacylglycerols (DAGs)</td>
<td>Fresh extra virgin olive oil contains a high proportion of 1,2-diacylglycerols to 1,2- and 1,3-diacylglycerols, while olive oil from poor quality fruits and refined olive oils have higher level of 1,3-DAGs than fresh extra virgin olive oils.</td>
<td>A low ratio of 1,2-diacylglycerols to 1,2- and 1,3-diacylglycerols is an indicator for oil that is hydrolyzed, oxidized, and/or of poor quality.</td>
<td>Gas Chromatography (GC)</td>
<td>≥ 35%</td>
</tr>
<tr>
<td>Pyropheophytin a (PPPs)</td>
<td>Chlorophyll pigments break down to pheophytins and then pyropheophytins upon thermal degradation of olive oil.</td>
<td>An elevated level of pyropheophytins is an indicator for oil that is oxidized and/or adulterated with refined oil.</td>
<td>High performance liquid chromatography (HPLC)</td>
<td>≤ 17%</td>
</tr>
<tr>
<td>Organoleptic</td>
<td>Organoleptic attributes refer to taste, odor and mouthfeel.</td>
<td>Organoleptic assessment can help identify oils that are of poor quality, oxidized, and/or adulterated with other oils.</td>
<td>IOC-recognized panel of 8-12 people evaluates oils for sensory characteristics</td>
<td>Median of defects = 0.0; Median of fruity &gt; 0.0</td>
</tr>
</tbody>
</table>