

Report

Evaluation of Olive Oil Sold to Restaurants and Foodservice

Selina Wang, PhD; Edwin Frankel, PhD; and Dan Flynn



Chef Paul Bartolotta

Photo: Jeremy Clow

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SUMMARY

The UC Davis Olive Center evaluated 21 olive oil samples sold to the restaurant and foodservice sectors based on the voluntary standards of the United States Department of Agriculture (USDA) and tests that have been adopted by the International Organization for Standardization (ISO). Our analysis found that:

- All but one of the 15 “extra virgin” samples passed the most commonly used USDA chemistry standards (free fatty acidity, peroxide value, and ultraviolet absorbance) to test quality;
- Despite this high passage rate, 60 percent of the samples failed the USDA “extra virgin” sensory standard, which is a standard rarely used for quality-control purposes in the foodservice and restaurant sectors. Some of the oils were so defective that they were classified by sensory panels as “not fit for human consumption” under the USDA standard;
- All of the “extra virgin” samples that failed the USDA sensory standard also failed the diacylglycerol (DAGs) standard adopted by the Australian Olive Association (AOA);
- Six of nine of the “extra virgin” samples that failed the USDA sensory standard also failed the pyropheophytin (PPP) standard adopted by the AOA;
- Chemical purity tests indicated that one of 15 “extra virgin” samples and one of six “olive oil” samples were adulterated with inexpensive canola oil.

We recommend: further research using a larger sample size than that used in this study; that the USDA revise extra virgin standards to include the DAGs and PPP tests; that food distributors augment their quality control protocols with the sensory, DAGs, and PPP tests; further research to develop tests that are faster, better and cheaper than the tests currently available; and further research on innovative packaging to extend olive oil freshness.

METHODOLOGY

Sodexo, the largest foodservice provider in the United States, assisted the research team in acquiring the 21 olive oil samples evaluated in this study.¹ The UC Davis team sent samples to the Australian National Oils Laboratory for sensory and chemical testing. The research team also sent the samples for sensory testing in Spain and Italy.² The analytical methods used in this study include the methods specified in the voluntary chemistry and sensory standards for olive oil adopted by the United States Department of Agriculture (USDA),³ which are nearly identical to standards adopted by the International Olive Council (IOC). The study also uses chemical methods that have been recognized since 2009 by the International Organization for Standardization (ISO), which adopted the methods after a rigorous review.⁴ All tests were performed “blind,” without knowledge of brand name or origin, by the laboratory and sensory panels.

RESULTS FOR “EXTRA VIRGIN” OLIVE OIL SAMPLES

“Extra virgin” is the top olive oil grade according to USDA standards. Quality control efforts often focus on three chemical standards for the grade: free fatty acidity (FFA), peroxide value (PV) and ultraviolet absorbance (K232, K268 and ΔK). As shown in Table 1, when the research team evaluated the 15 “extra virgin” samples

Table 1. Nearly all of the “extra virgin” olive oils passed the most commonly used chemical standards

EXTRA VIRGIN BRAND USDA STANDARD	FFA ≤0.8	PV ≤20	UV K232 ≤2.50	UV K268 ≤0.22	UV ΔK ≤0.01
Arrezzo	0.41	11	1.84	0.14	<0.003
Auguri	0.53	14	3.45	0.33	<0.003
Corto	0.35	8	1.80	0.15	<0.003
De Cecco	0.26	7	1.90	0.12	<0.003
LA Organic Cuisine	0.24	7	1.99	0.15	<0.003
La Romanella	0.41	8	2.08	0.18	0.004
O Olive Oil	0.60	9	1.87	0.10	<0.003
Primio	0.51	10	2.02	0.13	<0.003
Primo Gusto	0.30	11	1.89	0.13	<0.003
PrimOli	0.29	7	1.82	0.14	<0.003
Roland	0.50	13	1.88	0.13	<0.003
Suprema	0.44	9	2.15	0.19	<0.003
Supreme	0.40	10	1.85	0.13	<0.003
Supremo Italiano	0.28	11	2.38	0.15	<0.003
Sysco International	0.64	9	2.02	0.17	<0.003

FFA % as oleic acid; PV mEq O₂/kg oil; UV K¹%_{1cm}

based on the USDA standards for those tests, all but one of the samples passed. This finding is consistent with studies conducted by UC Davis in 2010 and 2011.

The oils also were analyzed using three standards that are infrequently used for quality-control purposes in the foodservice and restaurant sectors: the USDA sensory panel standard and the ISO-approved methods for diacylglycerols (DAGs) and pyropheophytin (PPP).

The USDA sensory standard is minimal: it merely requires that extra virgin have a median of defects equal to zero and a median of fruitiness greater than zero when analyzed by a trained panel of at least eight tasters.⁵ As shown in Table 2, when the 15 “extra virgin” olive oil samples were evaluated by three trained sensory panels (located in Australia, Spain and Italy), nine of the oils did not pass even that minimal standard, failing at least two of the three sensory panels. This 60 percent failure rate is similar to what UC Davis found in studies conducted in 2010 and 2011.

The most common sensory defects were rancid (descriptors include “stale walnuts,” “crayons” and “waxy”), fusty/muddy sediment (“olive mill waste pond,” “baby diapers” and “sweaty gym clothes”) and musty (“moldy” and “earthy”).⁶ Some oils were so strongly defective that the sensory panel analysis classified the oils as “lampante” (lamp oil), a grade “not fit for human consumption without further processing” according to the USDA standard.⁷

Table 2 also shows that all of the brands that failed the sensory test also failed the DAGs standard, and six of the nine failed the PPP standard. Taken together, the DAGs and PPP tests indicate that the failed oils were old, hydrolyzed, oxidized, of poor quality, and/or adulterated with cheap refined oil.⁸

To further explore the issue of adulteration, the research team analyzed the oils using several additional USDA tests summarized in Table 3. The Auguri sample failed all of the tests. Examination of the fatty acid profile showed that the Auguri sample exceeded the USDA limit for linolenic acid (C18:3) by 33 percent. Evaluation of the sterol profile showed that the Auguri sample exceeded the USDA brassicasterol limit by 3000 percent and the USDA campesterol limit by 186 percent, while having a low level of beta-sitosterol. All of these irregularities point toward refined canola oil in the sample. Auguri also exceeded the USDA limit for stigmastadiene by more than 16,000 percent, which confirms the presence of cheaper refined oil. The Supremo Italiano sample also exceeded the stigmastadiene limit by 153 percent, but the result is inconclusive given that the sample passed every other chemical and sensory test used in this study.

RESULTS FOR OLIVE OIL SAMPLES LABELED AS “OLIVE OIL” GRADE

“Olive oil” is a grade defined by the USDA as a blend of refined olive oil⁹ and virgin olive oils fit for human consumption.¹⁰

Table 4 indicates that five of the six samples passed the chemical standards for the “olive oil” grade. As with the

Table 2. Most of the “extra virgin” olive oil samples failed infrequently used standards

EXTRA VIRGIN BRAND AOA STANDARD	# OF SENSORY PANELS PASSED OUT OF 3	DAGs ≥40	PPP ≤15
Arrezzo	0	37.3	18.8
Auguri	0	29.7	24.9
Corto	3	61.9	4.3
De Cecco	3	47.5	11.9
LA Organic Cuisine	2	53.7	9.6
La Romanella	0	36.2	24.7
O Olive Oil	2	30.9	14.7
Primio	0	37.6	12.7
Primo Gusto	0	38.6	14.6
PrimOli	3	50.8	10.8
Roland	1	32.8	12.8
Suprema	0	28.7	21.0
Supreme	0	39.2	19.2
Supremo Italiano	3	54.1	7.3
Sysco International	0	30.1	40.6

Sensory Defects = 0 and Fruitiness > 0; DAGs % total 1,2- and 1,3-diacylglycerols; PPP % total pyropheophytins

team analyzed the oils using several additional USDA tests

Table 3. One “extra virgin” sample failed purity tests, indicating adulteration of the product

EXTRA VIRGIN BRAND USDA STANDARD	C18:3 ≤1.5	BRASSICASTEROL ≤0.1	CAMPESTEROL ≤4.5	BETA-SITOSTEROL ≥93.0	STIGMASTADIENE ≤0.15
Arrezzo	0.7	<0.05	3.2	94.9	<0.03
Auguri	2.0	3.13	12.9	81.3	24.24
Corto	0.8	<0.05	4.0	94.3	<0.03
De Cecco	0.7	<0.05	3.5	94.7	<0.03
LA Organic Cuisine	0.7	<0.05	3.4	94.5	<0.03
La Romanella	0.7	<0.05	3.3	95.0	<0.03
O Olive Oil	0.8	<0.05	2.7	95.2	<0.08
Primio	0.7	<0.05	3.3	94.9	<0.03
Primo Gusto	0.7	<0.05	3.2	95.0	<0.03
PrimOli	0.7	<0.05	3.2	94.5	<0.03
Roland	0.7	<0.05	3.2	94.9	<0.03
Suprema	0.7	<0.05	3.2	94.9	<0.03
Supreme	0.7	<0.05	3.2	94.8	<0.03
Supremo Italiano	0.7	<0.05	4.0	94.0	0.38
Sysco International	0.7	<0.05	3.0	94.7	<0.03

C18:3: % m/m methyl esters; Brassicasterol, Campesterol and Beta-sitosterol % total sterols; Stigmastadiene mg/kg

“extra virgin” samples, all six brands of the “olive oil” grade passed the commonly used tests for FFA, PV and ΔK. The Auguri sample, however, failed several other tests, clearly indicating that the sample was adulterated. Auguri failed USDA fatty acid profile standards, with low levels of palmitic acid (C16:0) and high levels of linolenic acid (C18:3) and eicosenoic acid (C20:1). Auguri also failed the USDA sterol profile standards, revealing high levels of brassicasterol, campesterol, and diols, and low levels of beta-sitosterol. These irregularities indicate adulteration with canola oil in higher concentrations than the Auguri “extra virgin” olive oil. The research team examined a second sample of Auguri “olive oil,” shipped from a different location from the first sample, and found similar evidence of adulteration.

Table 4. Chemical tests indicate that one of the olive oil samples was adulterated with canola oil

OLIVE OIL BRAND USDA STANDARD	FFA ≤1.0	PV ≤15	UV ΔK ≤0.15	UV K268 ≤0.22	C16:0 7.5-20	C18:3 ≤1.5	C20:1 ≤0.4	BRASSICA- STEROL ≤0.1	CAMPE- STEROL ≤4.5	DIOLS ≤4.5	BETA- SITOSTEROL ≥93.0
Arrezzo	0.18	4	0.052	0.56	10.9	0.7	0.3	0.05	2.9	3.7	94.6
Auguri	0.00	10	0.053	1.12	6.9	4.9	0.8	6.00	23.0	6.6	69.0
Del Papa	0.22	6	0.061	0.64	11.1	0.6	0.3	0.09	3.2	3.4	94.2
Gordon Food Service	0.11	5	0.047	0.55	11.0	0.7	0.3	0.05	3.1	3.7	94.4
La Romanella	0.14	7	0.049	0.57	12.3	0.7	0.3	0.09	3.1	3.5	93.8
Trifoglio	0.30	8	0.061	0.00	11.9	0.7	0.3	0.05	3.0	2.9	94.7

FFA % as oleic acid; PV mEq O₂/kg oil; UV K¹%_{1cm}; C16:0, C18:3 and C20:1 % m/m methyl esters; Brassicasterol, Campesterol, Diols and Beta-Sitosterol % total sterols

CONCLUSIONS

This initial review of the quality and authenticity of olive oil indicates that quality-control efforts in the restaurant and foodservice sectors may be unreliable if they are based on the most commonly used FFA, PV, and UV standards. Our results found that almost all olive oil passes these commonly used standards, even when the rarely used sensory standard finds that the oils are not fit for human consumption. More useful for determining quality are the sensory, DAGs, and PPP standards. These results are consistent with the UC Davis review of 186 samples pulled from supermarkets in 2010 and 2011.

We recommend:

- further research into the oil quality of the restaurant and foodservice sectors that includes a larger sample size than that used in this study;
- that the USDA revise extra virgin standards to include the DAGs and PPP tests;
- that the restaurant and foodservice sectors add the sensory, DAGs and PPP tests to their quality-control protocols;
- further research to develop tests that are faster, better and cheaper than the tests currently available; and
- further research on innovative packaging that will extend olive oil freshness.

SAMPLE INFORMATION

EXTRA VIRGIN BRAND	PRODUCTION AND DISTRIBUTION INFORMATION	IDENTIFYING INFORMATION	COST PAID (OZ)
Arrezzo	Umbria Olii International; Sysco, Boston MA	550224-5846714, 03061-03852720	0.13
Auguri	Mediterranean Olive Oil Corp; Sysco, Sacramento CA	A027M12	0.16
Corto	Corto-Olive; Sysco, Sacramento CA	04612C, 20501	0.17
De Cecco	Prodotti Mediterranei, Inc.; Restaurant Depot, Sacramento CA	LO7411TE	0.15
LA Organic Cuisine	La Amarilla de Ronda; Sysco, Sacramento CA	L122504	0.74
La Romanella	Amerifoods Trading Co.; Smart and Final, Sacramento CA	L306U11	0.21
O Olive Oil	O Olive Oil; Sysco, Sacramento, CA	none	1.11
Primio	Specialty Marketing Group; Sysco, Boston MA	L.11/319A	0.13
Primo Gusto	Limson Trading, Inc.; Gordon Food Service, Kenosha WI	Lot 12626001	0.29
PrimOli	Fattorie Giacobazzi SRL, Sysco, Sacramento CA	Annata: 10, Lotto: 4190	0.59
Roland	American Roland Bruno Scheidt Vega, Shamrock Foods, Denver CO	product # 1926071, L0623, Lot 731	price not specified
Suprema	Costa d Oro Spa, Sysco, Sacramento CA	00471-5M2359	0.22
Supreme	Sysco, distribution location not specified	11401-3984570, 550224-4497301	0.15
Supremo Italiano	R-D Enterprises, Restaurant Depot, Sacramento CA	1722500	0.14
Sysco International	US Food Group, Sysco, distribution location not specified	012497-6017115	0.27

OLIVE OIL BRAND	PRODUCTION AND DISTRIBUTION INFORMATION	IDENTIFYING INFORMATION	COST PAID (OZ)
Arrezzo	Umbria Olii International; Sysco, Boston MA	014711-8E6271, 551806-5847029	0.14
Auguri	Mediterranean Olive Oil Corp.; Sysco, San Francisco CA	G202M11	0.14
Del Papa	Umbria Olii International; Birite Food Service, Brisbane CA	L216U11-PO#516252	0.18
Gordon Food Service	Limson Trading Inc.; Gordon Food Service, Kenosha WI	Lot 1251	0.17
La Romanella	Amerifoods Trading Co.; Smart and Final, Sacramento CA	L059U11	0.18
Trifoglio	Rema Foods; Shamrock Foods, Denver CO	L259U11-R110025	0.23

AUTHORS



Selina C. Wang, PhD, Principal Investigator Dr. Wang is research director of the UC Davis Olive Center, where she has focused on quality analysis, innovative methods, and sustainable processing. She oversees the operation of the UC Davis Olive Oil Chemistry Laboratory, which offers research and fee-based analysis. She received her PhD from the UC Davis Department of Chemistry and has served as a lecturer in the UC Davis Department of Food Science and Technology.

Edwin N. Frankel, PhD Dr. Frankel is senior scientific advisor to the UC Davis Olive Center and among the world's leading authorities on lipid oxidation. A former adjunct professor at the UC Davis Department of Food Science and Technology, he was ranked as the world's most-cited author of agricultural research by the Institute for Scientific Information in 2003-04. Dr.

Frankel also spent 31 years working as a scientist with the United States Department of Agriculture, specializing in refined, bleached and deodorized vegetable oils.



Dan Flynn Mr. Flynn is the executive director of the UC Davis Olive Center, which seeks to do for olives what UC Davis did for wine. The Olive Center features 30 faculty members, research specialists and farm advisors who form an effective multi-disciplinary partnership. Mr. Flynn leads the center's efforts in research, education, and product testing for professional growers, processors and buyers of table olives and olive oil.

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NOTES

¹ Sodexo and the UC Davis Olive Center initially identified a sampling of 12 brands in the “extra virgin” grade and 12 brands in the “olive oil” grade based on the highest sales volume for Sodexo in the previous calendar year. Sodexo purchased the olive oil samples through the distributors carrying the brands. Sodexo was able to acquire many of the brands using this methodology, but in some cases Sodexo and the research team needed to substitute alternative brands obtained from the nearest distributor to UC Davis. In addition, the UC Davis team acquired four brands from two major cash-and-carry companies that serve restaurants and foodservice, Restaurant Depot (with locations in 27 states) and Smart and Final (located in the Western U.S. and Mexico.) The research team had a total of 15 “extra virgin” graded brands and six “olive oil” brands. Oils were stored in temperature-controlled facilities at UC Davis prior to shipping.

² The additional sensory panels were operated by Institut de Recerca i Tecnologia Agroalimentàries (IRTA) in Reus, Spain and Stazione Sperimentale per le Industrie degli Oli e dei Grassi (SSOG) in Milan, Italy.

³ United States Department of Agriculture (USDA), *United States Standards for Olive Oil and Olive-Pomace Oil*, October 25, 2010.

⁴ These tests, 1,2 diacylglycerols (DAGs) and pyropheophytin (PPP), were developed in Germany by Dr. Christian Gertz at the DGF laboratory <http://www.dgfett.de/>. The DAGs and PPP standards must be met by members of the Australian Olive Association (AOA) to receive AOA certification for extra virgin olive oil. This study used the AOA standard used in previous UC Davis Olive Center studies released in July 2010 and April 2011.

⁶ USDA, *op.cit.*, p.3.

⁶ Descriptors taken from the *Olive Oil Defects Wheel* published by Susan Langstaff in cooperation with the Instituto de la Grasa (Seville, Spain.)

⁷ USDA, *op.cit.*, p.3. “U.S. Virgin Olive Oil Not Fit For Human Consumption Without Further Processing” sometimes designated as “U.S. Lampante Virgin Olive Oil.”

⁸ See the UC Davis study from [2010](#), p. 5, to learn about DAGs, PPP and other chemical tests in this report.

⁹ USDA, *op.cit.*, p. 4. Refined olive oil is defined by the USDA as a flavorless and odorless olive oil that has undergone a refining process that has not altered the initial glycerin-fatty acid structure of the oil.

¹⁰ USDA, *op.cit.*, p. 2 The USDA defines virgin olive oils as a class of oils that have been produced solely by mechanical or other physical means. The two grades of virgin oils fit for human consumption are “extra virgin” and “virgin.” The USDA standard says that “virgin” graded olive oil can have a level of sensory defects up to a 2.5 median score from a sensory panel. There are no standards for DAGs, PPP, stigmastadiene or K232 for “virgin” olive oil.