

Report

Fatty acid and sterol profiles of olive oil produced in the United States

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Introduction

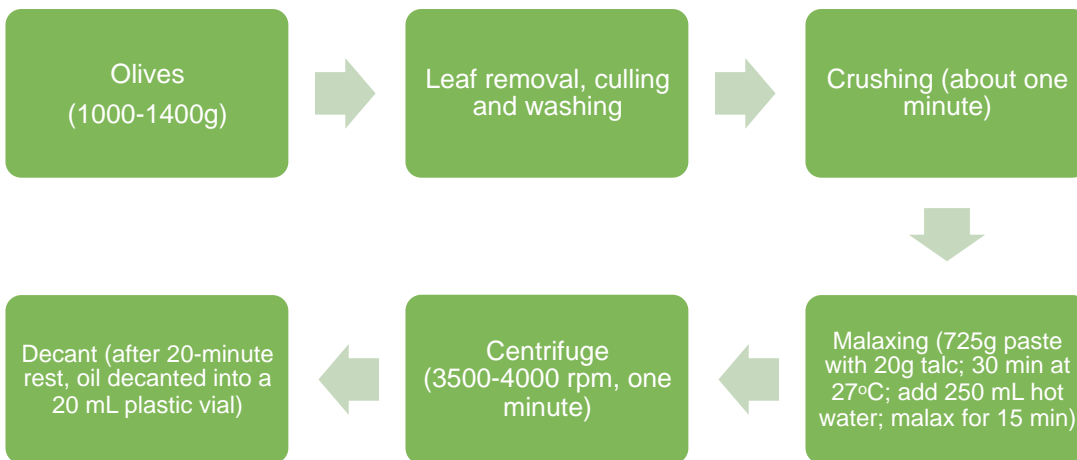
The United States Department of Agriculture (USDA) has established voluntary olive oil standards, which are based largely on standards adopted by the International Olive Council (IOC). USDA standards include an acceptable range for each fatty acid and sterol, seeking to ensure that olive oil is not adulterated with other types of oils. In this study, the UC Davis Olive Center collected US-grown olives and processed the olives at campus facilities to determine the extent that the oils would be accommodated by USDA standards for fatty acid and sterol profiles.

Methodology

The UC Davis Olive Center selected six cultivars for the study (Arbequina, Koroneiki, Leccino, Barnea, Pendolino, and Picual) based on a 2010 Australian study showing that the fatty acid and sterol profiles for many of these cultivars were often outside the IOC limits.¹ The Olive Center added a seventh cultivar, Arbosana, due to its prevalence in olive-growing districts of the United States.

The research team collected samples and processed the olives into oil during the 2012 and 2013 harvest seasons. The olives were delivered to the center in good condition and processed with the Abencor system within 24 hours of harvest when possible, otherwise the olives were refrigerated at 45 °F and processed the next day. The UC Davis Olive Center analyzed the fatty acid profile and the UC Davis Analytical Laboratory analyzed the sterol profile of the samples. Figure 1 shows how the research team carried out olive oil processing.

Figure 1. Olive oil processing on the Abencor system



¹ Mailer, Rodney J., Ayton, Jamie, Graham, Kerrie, The Influence of Growing Region, Cultivar and Harvest Timing on the Diversity of Australian Olive Oil, J Am Oil Chem Soc (2010) 87:877-884

Table 1 shows that 38 olive samples were received by the research team from various US locations, showing, for example, that three samples (Arbequina, Arbosana, and Koroneiki) were received from Lakeland, Georgia in 2013.

Table 1. Location and olive cultivars

	Arbequina	Arbosana	Koroneiki	Pical	Pendolino	Leccino	Barnea	Total
Lakeland, Georgia (2013)	1	1	1	-	-	-	-	3
Clayton, California (2013)	1	-	-	-	-	-	-	1
Davis, California (2013)	1	1	1	1	1	1	1	7
Davis, California (2012)	1	1	1	-	1	1	1	6
Devers, Texas (2013)	1	-	1	-	-	-	-	2
Corning, California (2013)	-	-	-	1	-	-	-	1
Corning, California (2012)	-	-	-	1	-	-	-	1
Imperial Valley, California (2013)	1	1	1	-	-	-	-	3
Imperial Valley, California (2012)	-	1	1	-	-	-	-	2
Petaluma, California (2013)	-	-	-	-	1	1	-	2
Petaluma, California (2012)	1	-	1	1	1	1	-	5
Dayton, Oregon (2013)	1	-	1	1	-	1	-	4
Dayton, Oregon (2012)	1	-	-	-	-	-	-	1
Total	9	5	8	5	4	5	2	38

Results

A total of 20 of the 38 olive oil samples (53 percent) failed USDA standards for fatty acid or sterol profiles. Table 2 summarizes the results by cultivar and location, showing, for example, that 56 percent of the Arbequina samples (5 of 9 samples) failed one or more USDA standards for fatty acids or sterols. Arbequina is the most widely planted olive in the United States. Another widely planted olive, Koroneiki, had 75 percent of the samples (6 of 8 samples) failing USDA standards. Table 2 also shows that some growing areas had high failure rates, with all of the samples from Texas and the Imperial Valley failing at least one USDA standard for fatty acid or sterol profile.

Table 2. Samples failing USDA standards for fatty acid or sterol profile

	Arbequina	Arbosana	Koroneiki	Pical	Pendolino	Leccino	Barnea	Fail rate
Lakeland, Georgia	1	0	0	-	-	-	-	33%
Clayton, California	0	-	-	-	-	-	-	0
Davis, California	0	1	1	0	0	0	1	23%
Devers, Texas	1	-	1	-	-	-	-	100%
Corning, California	-	-	-	1	-	-	-	50%
Imperial Valley, California	1	2	2	-	-	-	-	100%
Petaluma, California	0	-	1	1	2	0	-	57%
Dayton, Oregon	2	-	1	1	-	0	-	80%
Fail rate	56%	60%	75%	60%	50%	0	50%	

Table 3 shows the number of cultivars failing specific fatty acids or sterols. Among the fatty acids, five olive oil samples (three Arbequina and two Arbosana) were outside the USDA standard for palmitic acid (C16:0), thus resulting in a fail rate of 13 percent (5 of 38 samples). Among the sterols, 24 percent (9 of 38 samples) failed the USDA standard for campesterol.

Table 3. Samples by cultivar that failed USDA standards for specific fatty acids and sterols

		Arbequina	Arbosana	Koroneiki	Picual	Pendolino	Leccino	Barnea	Fail rate
Fatty Acids	Palmitic Acid (C16:0)	3	2	0	0	0	0	0	13%
	Palmitoleic Acid (C16:1)	2	0	0	0	0	0	0	5%
	Heptadecenoic Acid (C17:1)	0	1	0	0	0	0	0	3%
	Oleic Acid (C18:1)	2	1	0	1	0	0	0	11%
	Linoleic Acid (C18:2)	1	1	0	3	0	0	0	13%
Sterols	Total Sterols	1	0	3	0	2	0	0	16%
	Cholesterol	0	0	1	0	1	0	0	5%
	Brassicasterol	0	0	1	0	0	0	0	3%
	Campesterol	2	2	4	0	0	0	1	24%
	Delta-7-stigmastenol	0	0	1	0	0	0	0	3%
	Uvaol + Erythrodiol	0	0	2	0	0	0	0	5%
	Clerosterol + Sitostanol + Beta-Sitosterol + Delta 5-24-Stigmastadienol + Delta-5-23-Stigmastadienol + Delta-5-Avenasterol	1	2	4	0	0	0	0	18%

A total of nine oil samples failed one or more USDA standards for fatty acid profile. Table 4 shows the specific fatty acid failed by cultivar and region. Two of the three cultivars that failed – Arbequina and Arbosana – are primary cultivars for olive oil production in the United States. Table 4 also shows that the failed Arbequina samples came from Georgia, Texas and the Imperial Valley and that the samples all exceeded 20 percent palmitic acid, which is the USDA limit.

Table 4. Olive oil samples by cultivar that failed fatty acid standards

	Arbequina			Arbosana			Picual		
	Georgia (2013)	Texas (2013)	Imperial (2013)	Imperial (2013)	Imperial (2012)	Davis (2012)	Oregon (2013)	Corning (2012)	Petaluma (2012)
Palmitic Acid (C16:0) (7.5% – 20.0%)	21.1	22.7	21.2	20.9	21.3	√	√	√	√
Palmitoleic Acid (C16:1) (0.3% – 3.5%)	3.6	4.4	√	√	√	√	√	√	√
Heptadecenoic Acid (C17:1) (≤0.3%)	√ ¹	√	√	√	√	0.4	√	√	√
Oleic Acid (C18:1) (55.0% – 83.0%)	√	51.4	50.8	√	51.0	√	√	√	84.1
Linoleic Acid (C18:2) (3.5% – 21.0%)	√	√	21.1	√	21.6	√	3.0	2.8	2.6

√: passed this specific parameter

There were 14 samples that failed USDA standards for sterols. Table 5 shows the specific standard failed by cultivar and region. The table shows, for example, that 9 of 38 samples failed the USDA standard for campesterol of ≤ 4.5 percent. Koroneiki samples were particularly prone to failure of sterol standards, with 6 of the 8 Koroneiki samples failing one or more sterol parameters.

Table 5. Olive oil samples by cultivar that failed sterol standards

	Arbequina			Arbosana		Koroneiki						Pendolino		Barnea
	Imperial 2013	Oregon 2013	Oregon 2012	Imperial 2013	Imperial 2012	Texas 2013	Imperial 2013	Imperial 2012	Oregon 2013	Davis 2012	Petaluma 2012	Petaluma 2013	Petaluma 2012	Davis 2013
Total Sterols (≥ 1000)	√	985	√	√	√	899	√	√	715	√	871	917	963	√
Cholesterol ($\leq 0.5\%$)	√	√	√	√	√	√	√	√	√	√	0.7	√	0.6	√
Brassicasterol ($\leq 0.1\%$)	√	√	√	√	√	√	√	√	√	√	0.2	√	√	√
Campesterol ($\leq 4.5\%$)	5.4	√	4.7	5.0	4.7	√	5.3	√	5.6	4.6	4.6	√	√	4.7
Delta-7-stigmastenol ($\leq 0.5\%$)	√	√	√	√	√	√	0.6	√	√	√	√	√	√	√
Uvaol + Erythrodiol ($\leq 4.5\%$)	√	√	√	√	√	√	√	4.8	√	√	5.1	√	√	√
Clerosterol + Sitosterol + Beta-Sitosterol + Delta 5-24-Stigmastadienol + Delta-5-23-Stigmastadienol + Delta-5-Avenasterol ($\geq 93.0\%$)	92.2	√	√	92.0	92.5	√	91.6	92.8	92.4	√	82.5	√	√	√

√: passed this specific parameter

Conclusion

Our analysis of the fatty acids and sterols in olive oil produced at UC Davis from 38 samples of US-grown olives indicates that authentic olive oil will often fail USDA standards. Given that there are seasonal variations in chemical data, we recommend that data collection continue as an ongoing research effort to strengthen understanding of the chemical profile of US-produced olive oil.

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