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SANGUIS JOVIS

ALTA SCUOLA DEL SANGIOVESE

V Edizione

SUMMER SCHOOL SANGUIS JOVIS

I FIGLI DEL SANGIOVESE NEL MONDO: STORIE, VINI, TERRITORI, MERCATI

From the World: conversazioni sincrone con la Napa Valley

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14 Luglio 2022

Sangiovese

Sangiovese is presumed to be an ancient autochthonous cultivar from Calabria and then diffused in Tuscany, and according to some authors, it was already known to the Etruscans.

It constitutes the basis of internationally known wines such as Chianti, Brunello di Montalcino, Nobile di Montepulciano and, furthermore, its use is allowed for the production of 11 DOCG (Denominazione di Origine Controllata e Garantita), 103 DOC (Denominazione di Origine Controllata) and 99 IGT (Indicazione Geografica Tipica) wines all over Italy.

It is the most widespread Italian red cultivar and, according to the last agricultural census of the Ministry of Agricultural, Food and Forestry Policies (http://catalogoviti.politicheagricole.it), the total area, planted with Sangiovese, was 69787 ha, equivalent to 10.3% of the area of all the Italian vineyards, 47% of these vineyards are in Tuscany, producing 92.5% of the Sangiovese world output.

*Literature: Breviglieri and Casini 1964; Calò et al. 2001; Fregoni 1991; Mainardi 2001

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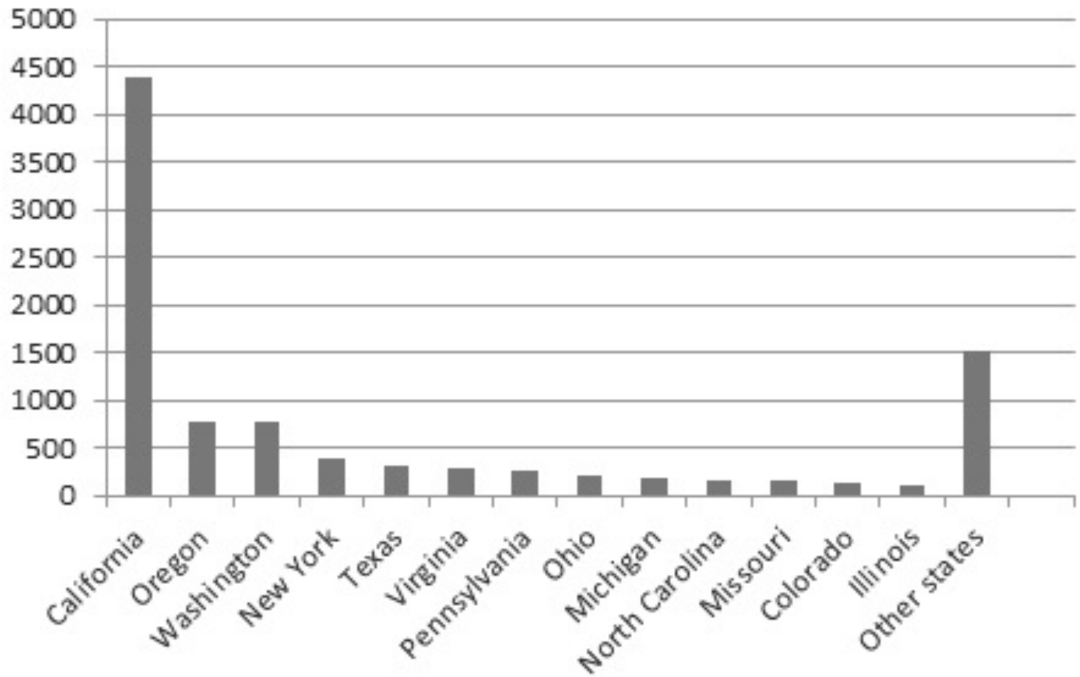
Sangiovese

Worldwide, Sangiovese has been introduced in different countries and regions by Italian immigrants. Its production is marginal when compared to other cultivars.

Argentina is the country outside Europe with the largest area where Sangiovese is cultivated with 2476 ha (3.3% of total global production), followed by the United States, mostly in California, with 1043 ha (1.4%) and Australia with 488 ha (0.6%) *(http://analisieconomiche.arsia.toscana.it)*.

From the World: conversazioni sincrone con la Napa Valley

Wineries in US



- **California – 3674 (47% Napa and Sonoma)**

- Washington – 689
- Oregon - 566
- New York State – 395
- Texas – 319
- Virginia – 276
- Pennsylvania – 261
- Ohio – 208
- Michigan – 184
- North Carolina – 165
- Missouri – 149
- Colorado – 127
- Illinois – 115

From the World: conversazioni sincrone con la Napa Valley

California Wines Profile

Sources: U.S. Tax and Trade Bureau; BW166; The Gomberg, Fredrikson Report; Global Trade Information Services; and California Dept. of Food & Agriculture. Statistics are for 2019.

1. Bonded winery number as of July 2020 includes all bonded winery production facilities; excludes second tasting rooms and other non-production bonded wine premises. Source: Wines Vines Analytics.

CALIFORNIA WINES

https://discovercaliforniawines.com/media-trade/statistics/

America's #1 Wine Producer

California makes 81% of U.S. wine & is world's 4th largest producer

4,200 Bonded Wineries[1]

Mainly family-owned businesses, many multi-generational

5,900 Winegrape Growers

Winegrapes are grown in 49 of 58 counties

620,000 Acres of Winegrapes

(256,975 hectares) 141 American Viticultural Areas. Vineyards preserve open space & scenic beauty

Embracing Sustainability

More than 80% of California's wine is produced in a Certified California Sustainable Winery

3.40 Million Tons of Winegrapes

Over 110 winegrape varieties contributing to California as a wine & food paradise

240 Million Cases in the U.S. Market

Volume of California wine sales in the U.S.

$1.29 Billion in Exports

U.S. wine exports, 95% from California, were 41.3 million cases

$40 Billion in Retail Value

Estimated retail value of all California wine sales in the U.S.

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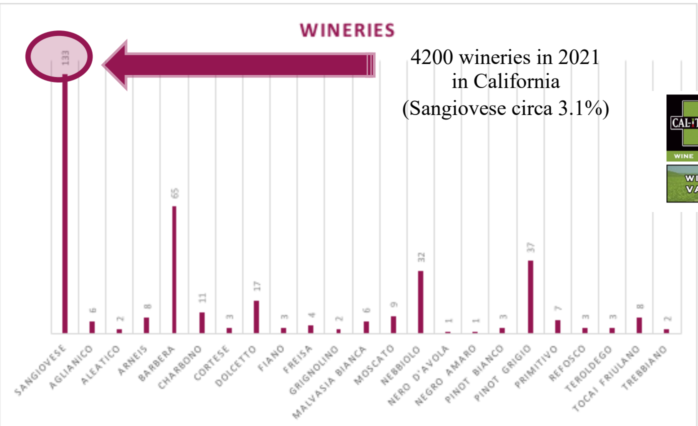
Sangiovese in California

Historically, Sangiovese was brought to California by Italian immigrants at the time of the Gold Rush in the 1850's. Some vines planted in the early 1900's still survive.

Sangiovese is planted in most of California's wine areas, including the prestigious North Coast, Sierra Foothills, Central Coast and the Central Valley.



*Literature: G. McGourty 2004

http://cal-italia.com/wine.html

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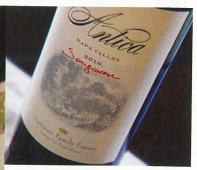
From the World: conversazioni sincrone con la Napa Valley

Sangiovese is a noble variety—the undisputed king in Tuscany, where it's behind Chianti Classico, Vino Nobile di Montepulciano, and Brunello di Montalcino. But it has virtually disappeared from U.S. shores. In the 1990s, it was The Next Big Thing, with acreage growing by 600 percent. Then came the roller-coaster plummet in the 2000s as countless wineries ripped it out. Why the backlash? And does any good sangiovese remain?

"THESE ARE CLONES THAT GO BACK TO ITALY, THAT NOBODY ELSE HAS IN THE STATES—AND ITALY POTENTIALLY HAS LOST," SAYS PETE SEGHESIO.



GETTING IT RIGHT: Noceto makes exemplary sangiovese *cru* in Amador County, while Antica's benefits from the Antinori touch and ideal vineyard plots. Photo: Patricia Thomson. Top: Head-pruned sangiovese vines at Chianti Station, dating back to 1910. Photo courtesy Seghesio

SONOMA PIONEERS

My first stop in California's Sonoma Valley is Seghesio Family Vineyards. Though known for their zinfandel, they're the largest sangiovese producer in Sonoma and own the oldest extant sangiovese vineyard in the country. In their Healdsburg tasting room, alongside sepia photos of mustached founder Eduardo Seghesio and his Gibson Girl wife, Angela, hangs a lithograph of Chianti Station. The scene is bucolic: a railroad depot surrounded by head-trained vines; wine barrels being readied for transport; a puffing steam engine.

It was directly across from this station that Edoardo Seghesio—part of a wave of immigrants from northern Italy—bought his first 10 acres in 1895. If people were coming to Sonoma to buy wine, he reasoned, they'd see his vineyard first. The strategy worked, and in 1910 Seghesio expanded, purchasing the southern edge of Italian Swiss Colony's vast property (owned by his wife's uncle), where they had planted a Chianti field blend: canaiolo, trebbiano, malvasia, and, presumably, the first sangiovese in the state.

Only one acre of that legacy vineyard remains (plus the railroad depot, bought for $20 by Angela after she learned Western Pacific Railroad planned to tear it down). But that acre is a precious archive of historic clones, brought from the Old Country by viticulturalist and brandy maker A.R. Morrow.

"That's the unique thing about our sangiovese," says Pete Seghesio Jr, Edoardo's grandson and CEO. "These are clones that go back to Italy, that nobody else has in the States—and Italy potentially has lost. We thought there was one clone, but it turns out there's four."

Seghesio makes two sangiovese bottlings from these propagated vines. The basic orange label ($30) comes from three clones planted on porous flatland, benchland, and hillside. The more intense, oak-aged Venom ($54) comes from the fourth clone—with the smallest berries and loosest clusters—planted on the formidable Rattlesnake Hill. "If you put it up against the great crus of Italian sangiovese—Monsanto Reserva, Biondi Santi, Brancaia—Venom stands up very well," says Seghesio.

"We put it on our toughest site. There's maybe five or six inches of top soil, so it naturally devigorizes it. We have 10 acres and never get over 20 tons total." That's a far cry from the Green Giant bounty of the 1990s. "I've heard stories of guys getting 10, 12 tons to the acre," he continues. "It's a joke. There were large plantings on incredibly fertile soil, valley floor. If you put sangiovese on a fertile site, you get huge berries, huge yields."

There's an old saying: The more a grapevine grows like a weed, the more it tastes like a weed. And that's the problem with sangiovese. A naturally vigorous vine, its growth must be tamed with repeated pruning, fastidious canopy management, and soil-poor sites on rocky slopes. Few Californians bothered to put in the effort or hand over their best vineyards—not when cabernet or pinot noir could fetch far greater returns. What's more, California's heat and lack of haze hasten sangiovese's ripening, which leaves its phenolics undeveloped and flavors truncated.

"Sangiovese is incredibly challenging," says Seghesio. "Both the Italians and California growers struggle with the same thing: Sangiovese can be a doughnut wine. How do you get the middle? Most Californians just blend cabernet. But if you get the yields low enough and do the right maceration techniques with fermentation, you can make a full wine."

During sangiovese's heyday, however, "everybody came out with a $35 sangiovese, and it was very mediocre or blended with cabernet," Seghesio continues. Consumers balked—why pay $35 when you can get a good Chianti Classico for under $20? "The whole category got poisoned, and the market turned against it," he sums up. "I've seen those early plantings of sangiovese all come out. I mean, even Antinori gave up."

THE ANTINORI IMPACT

If there's one name associated with the sangiovese boom, it's Antinori. By most accounts, its Atlas Peak Vineyard launched the 1990s juggernaut. But when I sit down with Glenn Salva, longtime estate manager of Antinori's Napa property, the story is more complicated. "A lot of people would say that Antinori was responsible for sangiovese's rapid climb," he says. "It wasn't."

Florentine vintners since 1385, the Antinoris have been tied to sangiovese for 26 generations. When Piero Antinori took the reins in 1966, he began traveling the wine world, coming frequently to Napa and befriending such pioneers as Robert Mondavi.

In 1985, an investment opportunity arose. British brewer Whitbread, which owned Antinori's importer, Julius Wile, decided to get into the California wine business. They invited Antinori and champagne house Bollinger

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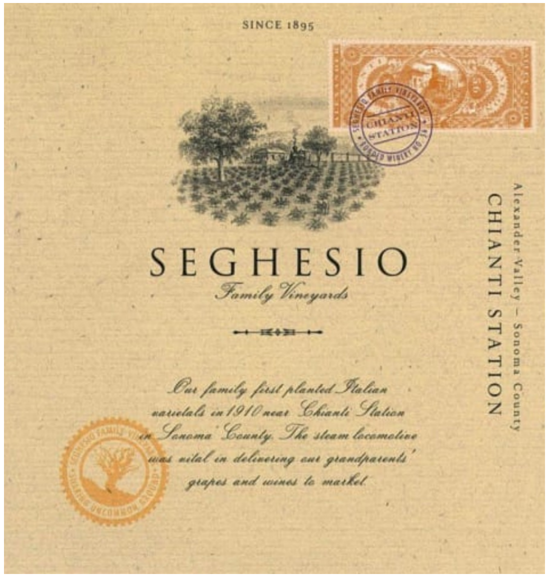

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VINO NOCETO

Welcome to Vino Noceto

Vino Noceto is where Italian inspiration collides with California sunshine to produce world class Sangiovese. Join us at our winery in beautiful Amador County, California, and come share our passion for wine.

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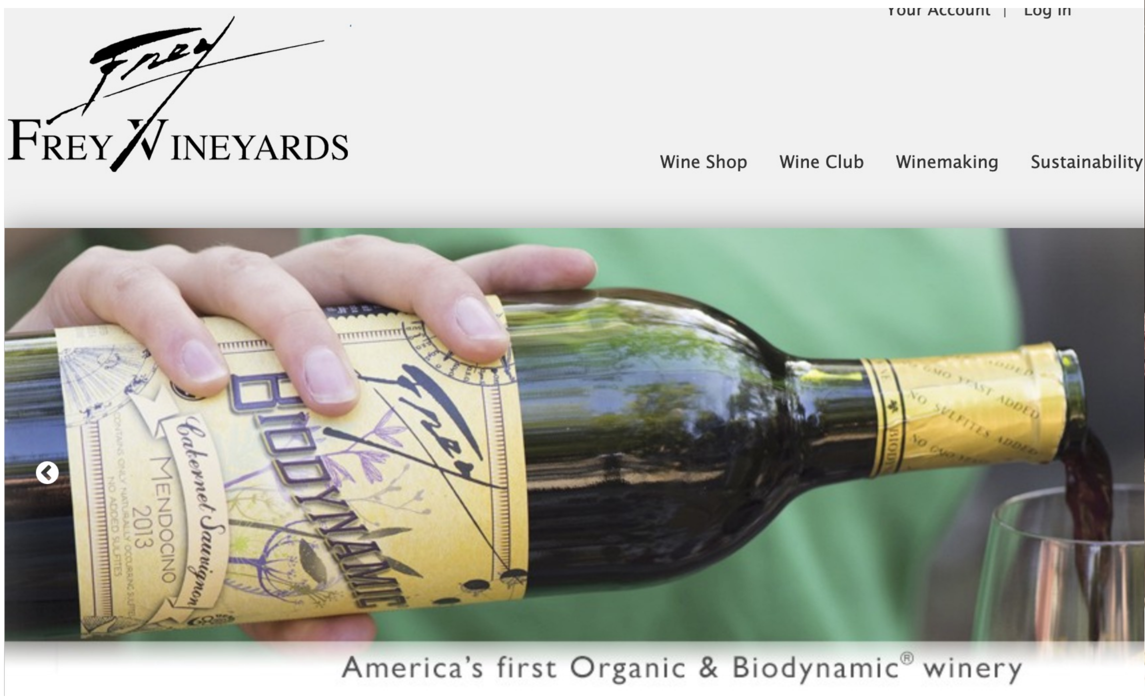
From the World: conversazioni sincrone con la Napa Valley

VINO NOCETO

9 different wines

From the World: conversazioni sincrone con la Napa Valley



Sangiovese grape and wine characteristics

AROMA PROFILE

- Neutral grape variety (not dependent upon monoterpenes for its flavour) [1]

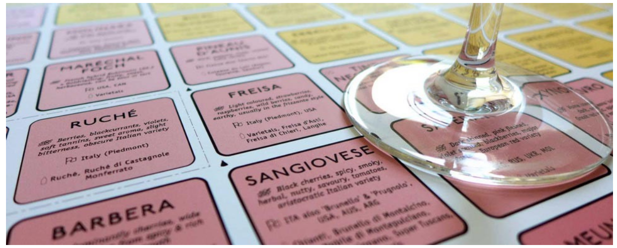
- However, the grapes and the wines showed some varietal compounds[2]:

1-Octen-3-ol β-Linalool 4-Terpineol α-Terpineol β-Citronellol Nerol
β-Damascenone Geraniol Benzyl alcohol β-Phenylethanol β-Ionone

PHENOLIC PROFILE

- Delicate pigment profile, not particularly rich in anthocyanins with respect to other cultivars and around 45% of unstable dihydroxy pigments (cyanidin-3-glucoside, delphinidin-3-glucoside, petunidin-3-glucoside)[3]

- less than 2% of acylated anthocyanins[3]



*Literature: [1]Mateo 2000; [2]Canuti 2017, [3]Mattivi, 2012.

Aim of the research

Regionality, frequently called terroir, is often used as a way to market wines from different locations.
For this reason, this study sought to define and compare Sangiovese wine composition from various regions in California and Italy.

STEP#1
Fifty-two commercial wines, 100% Sangiovese from 2016 harvest (20 from Italy and 32 from California), were analyzed for volatile aroma profiles, color indices, phenolic profiles and elemental composition.

STEP#2
Twenty commercial wines, 100% Sangiovese from 2017 harvest (9 from Italy and 11 from California), were analyzed for volatile aroma profiles, color indices, phenolic profiles and elemental composition. The sensory descriptor profile and the evaluation of typicality were performed

Two aspects were considered:
- *Chemical authentication*
- *Sangiovese identity*

From the World: conversazioni sincrone con la Napa Valley

2016 vintage

JOURNAL OF AGRICULTURAL AND FOOD CHEMISTRY

Article

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Chemical Characteristics of Sangiovese Wines from California and Italy of 2016 Vintage

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ABSTRACT: Sangiovese is the most widespread Italian red cultivar and constitutes the basis of internationally known wines such as Chianti and Brunello di Montalcino. Outside of Europe, Argentina is the largest producer, followed by the United States. This study sought to define and compare 2016 vintage Sangiovese wine composition from various production regions in California and Italy. Forty-six commercial Sangiovese wines from California and Italy were analyzed for volatile profile, color, phenolic, and elemental content. This study demonstrates that it is possible to determine regional differences among wines based on these chemical profiles. However, some Californian and Italian wine had similar chemical compositions. In order to compare Californian and Italian wines, Californian wine reference models were developed using the chemical parameters from Sangiovese wines, performing a Soft Independent Modeling of Class Analogy (SIMCA). To our knowledge, this is the first time that an extensive regionality study has been attempted for Sangiovese wines.

KEYWORDS: *elemental analysis, phenolic compounds, Sangiovese, SIMCA, volatile profile, wine regionality*

2017 vintage

foods

MDPI

Article

Evaluation of the Intrinsic and Perceived Quality of Sangiovese Wines from California and Italy

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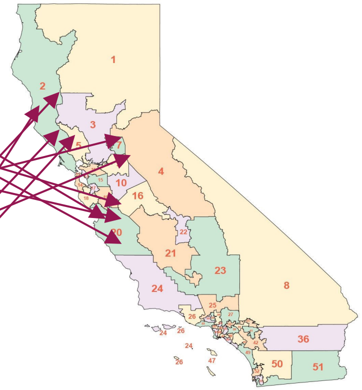
Abstract: Sangiovese is the most cultivated red grape variety in Italy where it is certified for the production of several Protected Designation of Origin (PDO) wines, and it is one of the most cultivated Italian red grape varieties in California. Despite the global distribution of this variety, there is a lack of international studies on Sangiovese grapes and wines. For this reason, the present study aimed to compare 20 commercial Sangiovese wines from 2017 harvest, 9 produced in Italy (Tuscany) and 11 in California, in order to evaluate the intrinsic and perceived quality. The eligibility, identity, and style properties (the intrinsic quality) of the wines were evaluated. A group of 11 Italian experts evaluated the perceived quality by rating the typicality of the wines. The experimental data showed that the intrinsic quality of Sangiovese wine samples was affected by the growing area; in particular, the wine resulted very different for the color indices and polyphenol composition. The above differences in intrinsic quality levels did not lead to a different evaluation of the perceived quality (typicality) by the wine experts. The results evidenced that Sangiovese variety is recognizable also if grown outside its original terroir, and fresh and fruity wines were considered more typical. This study expands our current knowledge of Sangiovese wines and the contribution of regional characteristics to the composition of wine.

Keywords: Sangiovese; wine regionality; intrinsic quality; perceived quality; sensory profile; volatile profile; polyphenol composition; typicality

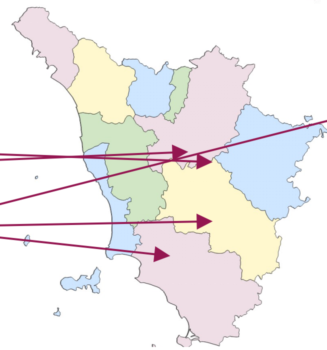
STEP#1 - Sangiovese wine samples

California	1	MC Monterey County (Central Coast)
	1	AC Alameda County (Central Coast)
	1	SL San Louis Obispo County, Paso Robles (Central Coast)
	3	SY Santa Ynez Valley (Central Coast)
	3	SJ Saint Joaquin Valley (Inland Valleys)
	10	AM Amador County (Sierra Foothills)
	2	RV Redwood valley (North Coast)
	1	SC Sonoma County (North Coast)
	9	NV Napa Valley (North Coast)
	1	ME Mendocino (North Coast)



14 Californian wineries
17 Italian wineries

Italia	11	CC Chianti Classico (Tuscany)
	4	CH Chianti (Tuscany)
	1	MA Maremma (Tuscany)
	2	MO Montalcino (Tuscany)
	2	ER Emilia Romagna



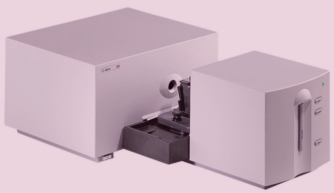
STEP#2 – Sangiovese wine samples

Table 1. Details of the wines in the study from California and Italy, including the region of origin and the standard chemical parameters. Only the wines 1I–6I and 7C–12C were analyzed for the sensory tests.

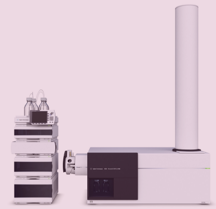
Wine Code	State/ Country	Region	Alcohol (v/v%)	Residual Sugar (g/L)	Titratable Acidity (g/L)	Volatile Acidity (g/L)	pH	Malic Acid (g/L)
1I	Italy	Chianti Classico (Tuscany)	13.65	<1	5.36	0.48	3.55	0.00
2I	Italy	Chianti Classico (Tuscany)	13.30	<1	6.32	0.39	3.38	0.00
3I	Italy	Chianti Classico (Tuscany)	14.26	<1	5.85	0.29	3.45	0.00
4I	Italy	Chianti Classico (Tuscany)	12.65	<1	5.80	0.42	3.31	0.00
5I	Italy	Chianti Classico (Tuscany)	13.85	1	7.60	0.35	3.24	0.17
6I	Italy	Chianti Classico (Tuscany)	14.04	1.12	5.18	0.43	3.42	0.19
13I	Italy	Chianti (Tuscany)	14.23	<1	6.48	0.52	3.31	0.85
14I	Italy	Chianti (Tuscany)	14.05	2.12	6.37	0.37	3.29	0.93
15I	Italy	Montalcino (Tuscany)	14.45	0.23	6.82	0.21	3.43	0.90
7C	California	Napa Valley (North Coast)	13.32	2.59	4.60	0.54	3.72	0.09
8C	California	Santa Ynez valley (Central Coast)	15.18	3.56	5.00	0.66	3.58	0.08
9C	California	Napa Valley (North Coast)	14.17	3.27	6.03	0.72	3.59	0.00
10C	California	Alameda County (Central Coast)	15.38	2.78	4.76	0.59	3.68	0.00
11C	California	Napa Valley (North Coast)	14.90	1.88	4.13	0.55	3.79	0.09
12C	California	Amador County (Sierra Foothills)	13.88	2.64	5.48	0.53	3.43	0.00
16C	California	Saint Joacquin valley (Inland Valley)	14.67	8.37	3.58	0.74	4.01	0.33
17C	California	Napa Valley (North Coast)	14.42	2.30	4.33	0.73	4.00	0.49
18C	California	Santa Ynez valley (Central Coast)	15.39	3.16	5.98	0.64	3.38	0.13
19C	California	Paso Robles (Central Coast)	14.61	1.83	4.96	0.53	3.60	0.00
20C	California	Amador County (Sierra Foothills)	14.58	2.89	6.77	0.26	3.42	1.27

Experimental plan

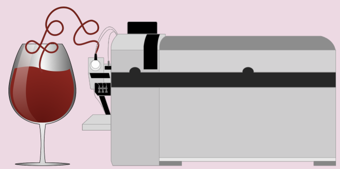
HS-SPME GC-MS analysis of flavor profile



Spectrophotometric analysis of color indices

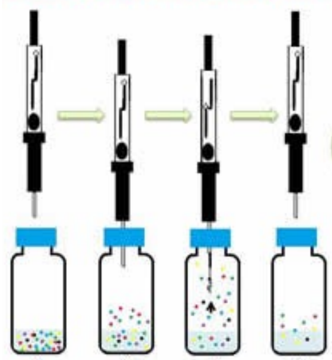


LC q-TOF analysis of polyphenols



Elemental analysis Inductively coupled plasma-mass spectrometric

HS-SPME GC-MS analysis of flavor profile



HS-SPME procedures

- PDMS fiber (polydimethylsiloxane) 100 µm thickness, 24 gauge
- 8 mL wine and 3 g of NaCl in 20 mL amber vial, were warmed to 40° C for 10 min before exposing the SPME fiber to the headspace of the sample.
- Headspace sampling/extraction times of 30 min were evaluated with continuous stirring (500 rpm)

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journal homepage: www.elsevier.com/locate/chroma

Headspace solid-phase microextraction–gas chromatography–mass spectrometry for profiling free volatile compounds in Cabernet Sauvignon grapes and wines

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Agilent Technologies

GC–MS analysis

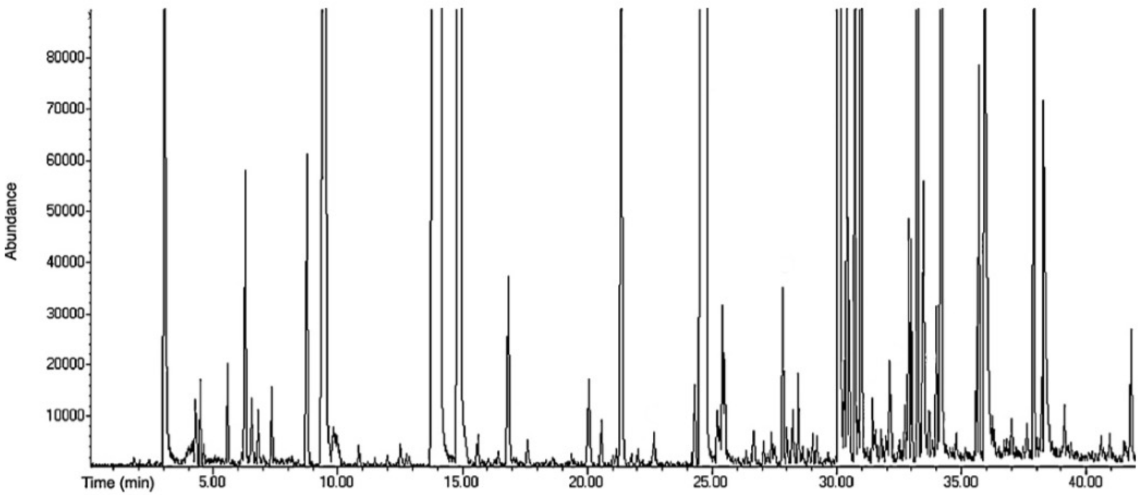
- Gerstel MPS2 autosampler (Gerstel, Baltimore, MD, USA) mounted to an Agilent 7890A gas chromatograph (Little Falls, DE, USA) paired with an Agilent 5975 mass selective detector constituted the analytical system.
- The software used was MSD ChemStation (G1701-90057, Agilent)
- DB-Wax column (30 m × 0.25 mm I.D., 0.25 µm film thickness) (J&W Scientific, Folsom, CA, USA)

HS-SPME GC-MS analysis of flavor profile

Quantitation

- Chemical aroma standard mixtures were prepared in a model solution similar to the wine and extracted in the same condition of wines
- The peak area of each standard (calculated as total ion) was related to the peak area of the 2-octanol internal standard

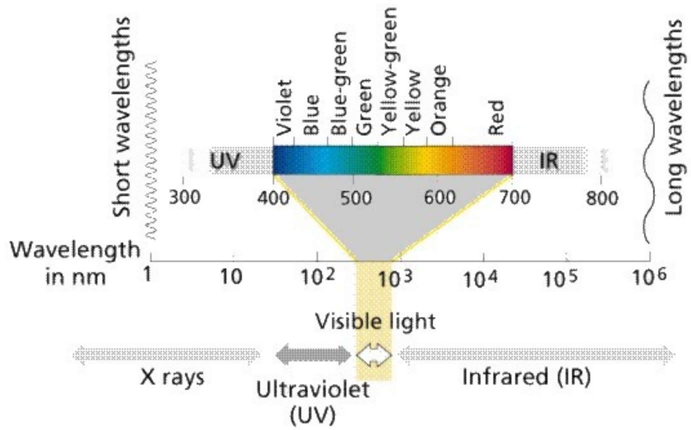
The MS detector *was operated in scan mode (mass range 50–200)*



Spectrophotometric analysis of color indices

Index	*Wavelenght*	*Method*	*Instrument*
Color Intensity	*abs (420+520+620)nm*	Glories, 1984	Cary 8453 UV-Visible spectrophotometer Diode array detector (Agilent Technology)
Hue	*abs 420 nm/abs 520 nm*	Glories, 1984	
Total Phenols Index	*abs 280 nm*	Ribereau-Gayon, 1970	

Agilent Technologies



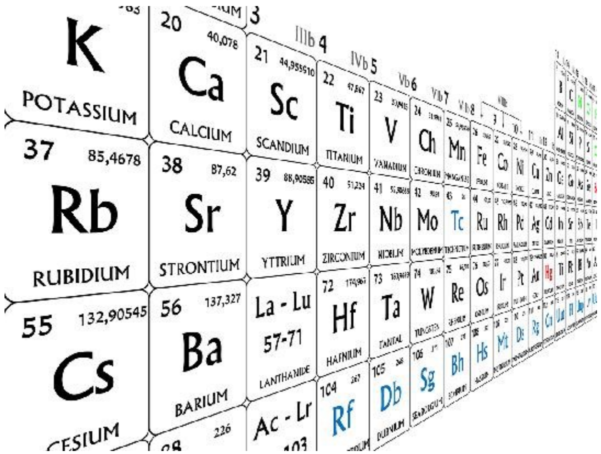
LC q-TOF Analysis

Instruments
- Mass spectrometer: Agilent 6545 Q-TOF LC/MS with Agilent JetStream ESI source operated in positive ion mode
- UHPLC: Agilent 1290 Infinity II (binary pump, thermostatted multisampler, and column compartment)

HPLC condition
- Column: Agilent Zorbax Eclipse Plus C18 RRHD (2.1 x 50 mm, 1.8-micron)
- Solvent A: Water + 1% formic acid; Solvent B: Methanol + 1% formic acid: Flow rate: 0.6 mL/minute. Column temp: 50C

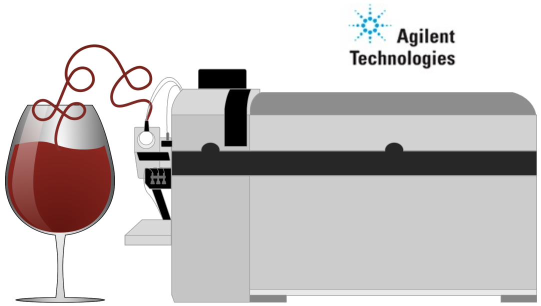
Data analysis
- Data was analyzed using Agilent Profinder (ver. 8) and the find by targeted feature wizard. A database of 88 known red wine phenolics was searched and matches were confirmed by both retention time and accurate mass.

Elemental Analysis



ICP-MS analysis

- Agilent 8800 ICP-QQQ (Agilent Technologies, UK) equipped with a Scott-type double-pass quartz spray chamber, MicroMist concentric nebulizer (Glass Expansion, Australia) and nickel sampler and skimmer cones.
- ICP-QQQ optimized with lab's tuning procedure
- QC blocks of continuing calibration verification (CCV), blanks, and CRMs were run every 20 samples
- He, HEHe, and O_2 Modes were used depending on the element in question



Sample Preparation

- 2 mL wine were diluted with a solution of 3% nitric acid and 1% hydrochloric acid to final volume of 10 mL (5 fold dilution).
- Calibration standards, blanks, and CRMs were made with matrix-matched solution of 3% nitric acid, 1% hydrochloric acid and 3% ethanol.
- 6-point calibration curves were created for all quantifed elements using multielement and single element standards.
- Diluted wine samples were centrifuged prior to analysis

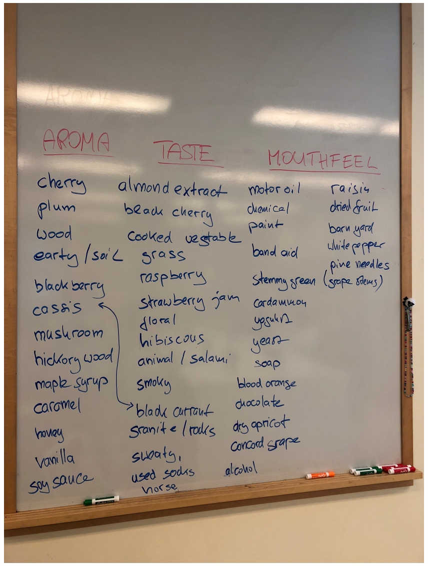
Sensory analysis

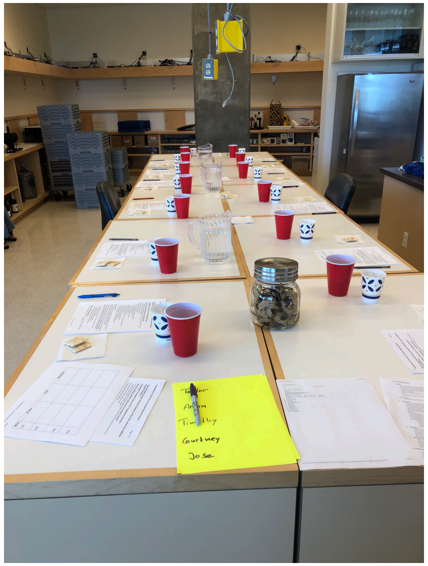
The descriptive sensory analysis

J. Lohr Sensory Room at the Department of Viticulture and Enology, University of California Davis

Training session:

the panel consisted of 11 judges (8 females and 3 male).





Sensory analysis

The descriptive sensory analysis

J. Lohr Sensory Room at the Department of Viticulture and Enology, University of California Davis

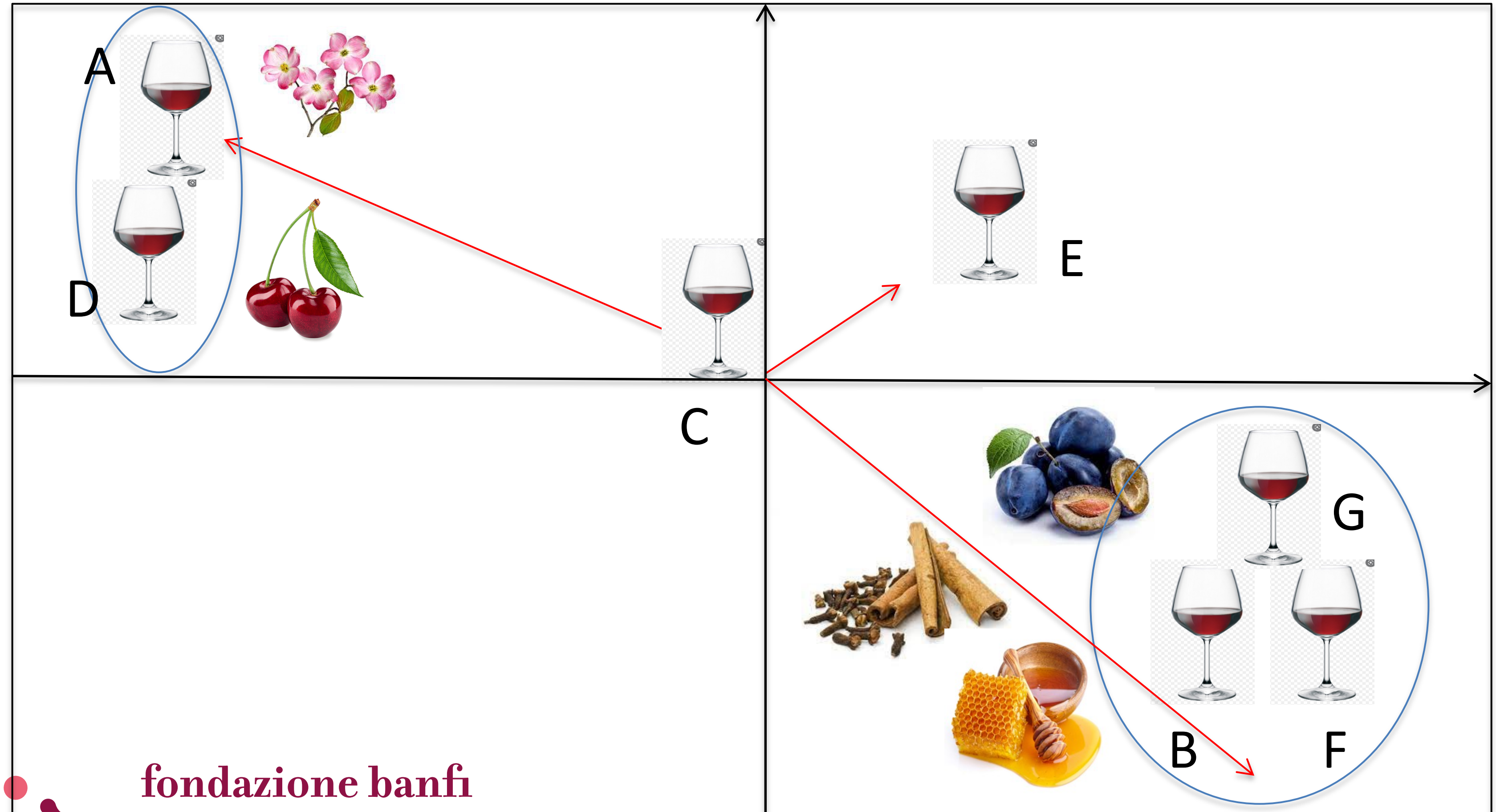
Samples evaluation:

the panel consisted of 11 judges (8 females and 3 male).


Sensory analysis

Perceived Quality: Napping® Test, Wine Rating of Color and Typicality

sensory laboratory at the Department DAGRI, University of Florence (Florence, Italy)



Sensory analysis

Perceived Quality: Napping® Test, Wine Rating of Color and Typicality

sensory laboratory at the Department DAGRI, University of Florence (Florence, Italy)

INTRINSIC QUALITY DEFINITION

Definition of typicality

Typicality is defined as the characteristics of a product from a terroir, meaning that the product is representative of its terroir.

Thus, typicality can be defined as a set of properties of belonging and distinction, described by an intrinsic and perceived quality (Casabianca et al. 2006).

Sensory analysis

Perceived Quality: Napping® Test, Wine Rating of Color and Typicality

sensory laboratory at the Department DAGRI, University of Florence (Florence, Italy)

INTRINSIC QUALITY DEFINITION

Considering the absence of defects as a pre-requisite, some authors (Bertuccioli et al., 2011; Canuti et al., 2017) proposed that the **intrinsic quality** is the resultant of three different profiles:

ELIGIBILITY
IDENTITY
STYLE

Parameters common to all wines

Eligibility profile

Parameters related to the grape variety and the terroir

Identity profile

Parameters related to the brand and expression of the winemaking

Style profile

Sensory analysis

Perceived Quality: Napping® Test, Wine Rating of Color and Typicality

sensory laboratory at the Department DAGRI, University of Florence (Florence, Italy)

The panelists were instructed as follows:

"Imagine that you wanted to explain to someone what a Sangiovese wine color is. To explain, you can suggest to this person to evaluate a wine. For each wine presented, you must answer the following question: Do you think that this wine is a good example or a bad example of what a Sangiovese wine color is?"

The score of each sample was assigned on a categorical scale, from 1 to 7, anchored at left to "*very bad color*" and on the right to "*excellent color*".

"Imagine that you wanted to explain to someone what a Sangiovese wine is. To explain, you can suggest to this person to taste a wine. For each wine presented, you must answer the following question: Do you think that this wine is a good example or a bad example of what a Sangiovese wine is?"

The score of every sample was assigned on a categorical scale, from 1 to 10, anchored at left to "very bad example" and on the right to "excellent example".

Results

1. Chemical authentication: definition and comparison of Sangiovese wines from Italy and California
2. The Sangiovese identity: the expression of the variety in two different countries

2016 vintage

Volatile compound	Country (Italy and California) *p-value*	Replicates *p-value*
Ethyl acetate	0.0000	0.8883
Isobutyl acetate	0.0000	0.9750
Ethyl butanoate	0.0000	0.9394
1-Propanol	0.0000	0.4681
Ethyl-2-methyl butyrate	0.0000	0.9825
Ethyl isovalerate	0.0000	0.9305
2-Methyl-1-propanol	0.2468	0.9504
Isoamyl acetate	0.0000	0.9447
3-Methyl-1-butanol	0.0035	0.8060
Ethyl hexanoate	0.0000	0.9624
Hexyl acetate	0.0000	0.9946
Ethyl lactate	0.0000	0.9052
1-Hexanol	0.0000	0.9531
Methyl octanoate	0.0000	0.9657
Ethyl octanoate	0.0000	0.9456
Vitispirane I	0.9309	0.3252
Benzaldeyde	0.4023	0.7254
Riesling acetal	0.0058	0.8474
Ethyl nonanoate	0.2334	0.9958
1-Octanol	0.0000	0.7902
Ethyl decanoate	0.7831	0.9104
Diethyl succinate	0.0283	0.5894
Ethyl-9-decenoate	0.0024	0.9899
β-farnesene	0.0579	0.3718
1,1,6-Trimethyl-1,2- dihydronaphthalene	0.6335	0.9539
β-citronellol	0.0000	0.9745
β-phenethylacetate	0.0000	0.9237
β-damascenone	0.2371	0.4195
Ethyl dodecanoate	0.5880	0.9825
Hexanoic acid	0.0070	0.8001
Ethyl-3-methylester	0.0323	0.9629
β-phenylethanol	0.0000	0.9657
Octanoic acid	0.0000	0.7478
Decanoic acid	0.0000	0.7267

Sangiovese wine aroma compounds

35 volatile compounds identified in both 2016 Sangiovese Italian and Californian wines

All compounds are significant except for:

2-Methyil-1-propanol
Vitispirane
Benzaldeyde
Ethyl nonanoate
Ethyl decanoate
β-farnesene
1,1,6-Trimethyl-1,2-dihydronaphthalene (TDN)
β-damascenone
Ethyl dodecanoate

Replicates are never significant

Varietal aroma
Sangiovese identity

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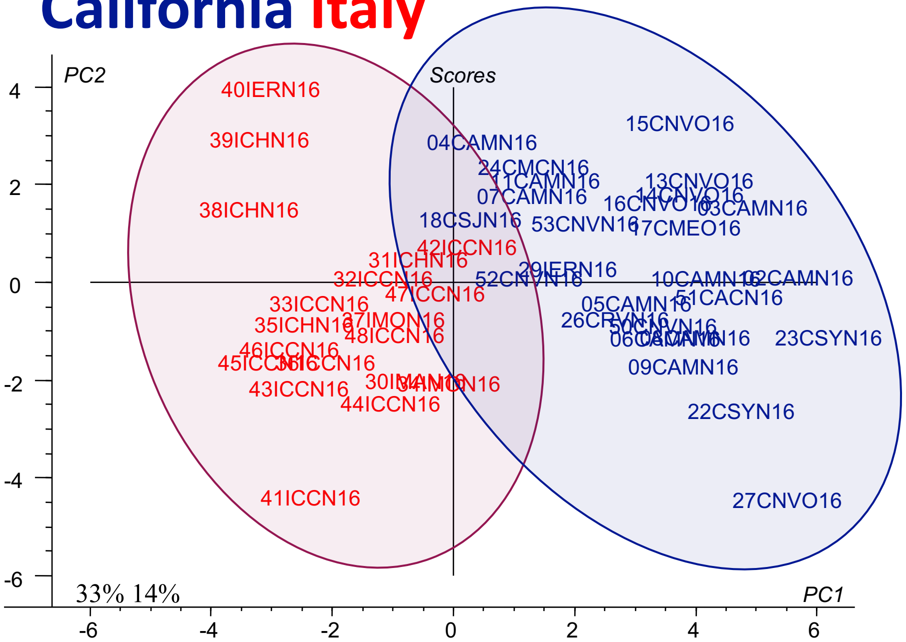
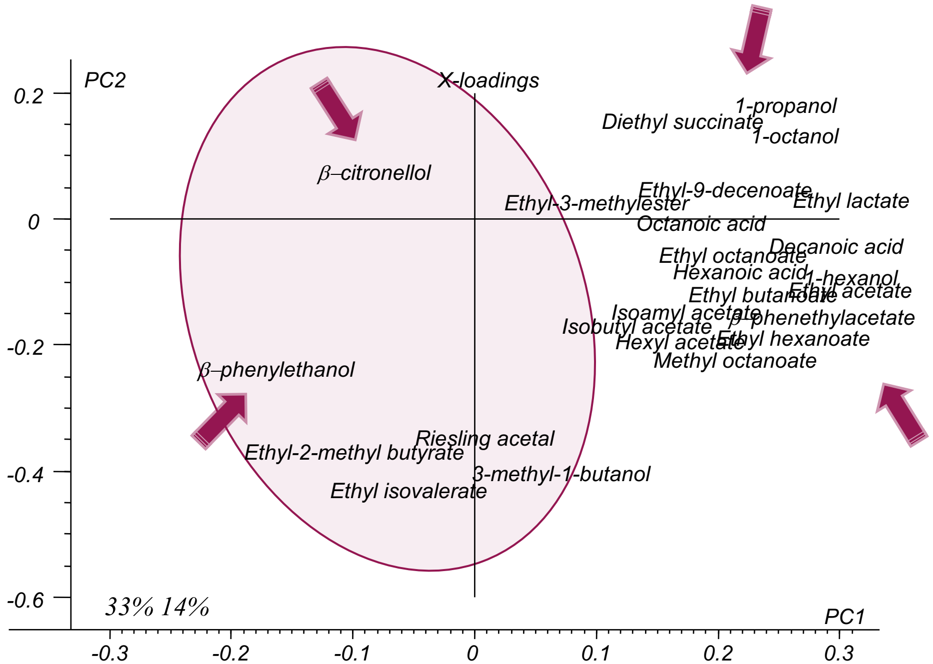
SANGUIS JOVIS

2016 vintage

California Italy



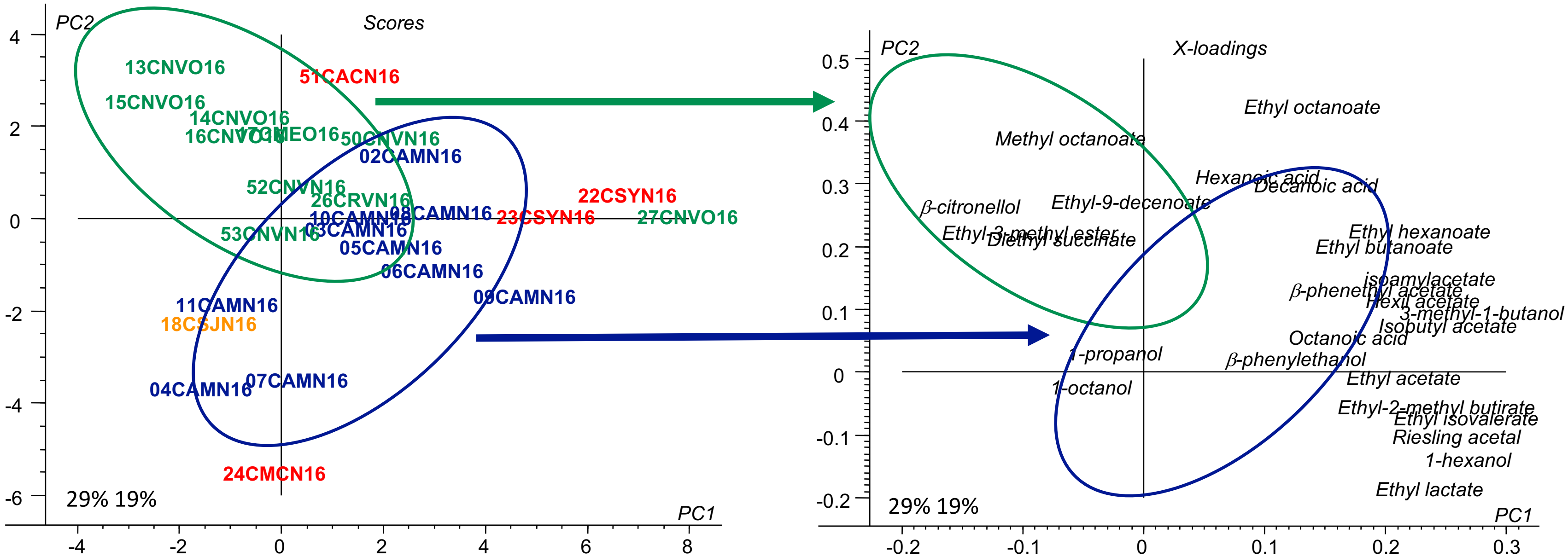


Only significant flavor compounds

Scores and loadings

2016 vintage

Sangiovese wines aroma: California



MC Monterey County (Central Coast)
AC Alameda County (Central Coast)
SY Santa Ynez Valley (Central Coast)
SJ Saint Joacquin Valley (Inland Valleys)
AM Amador County (Sierra Foothills)

RV Redwood Valley (North Coast)
SC Sonoma County (North Coast)
NV Napa Valley (North Coast)
ME Mendocino (North Coast)

Scores and loadings

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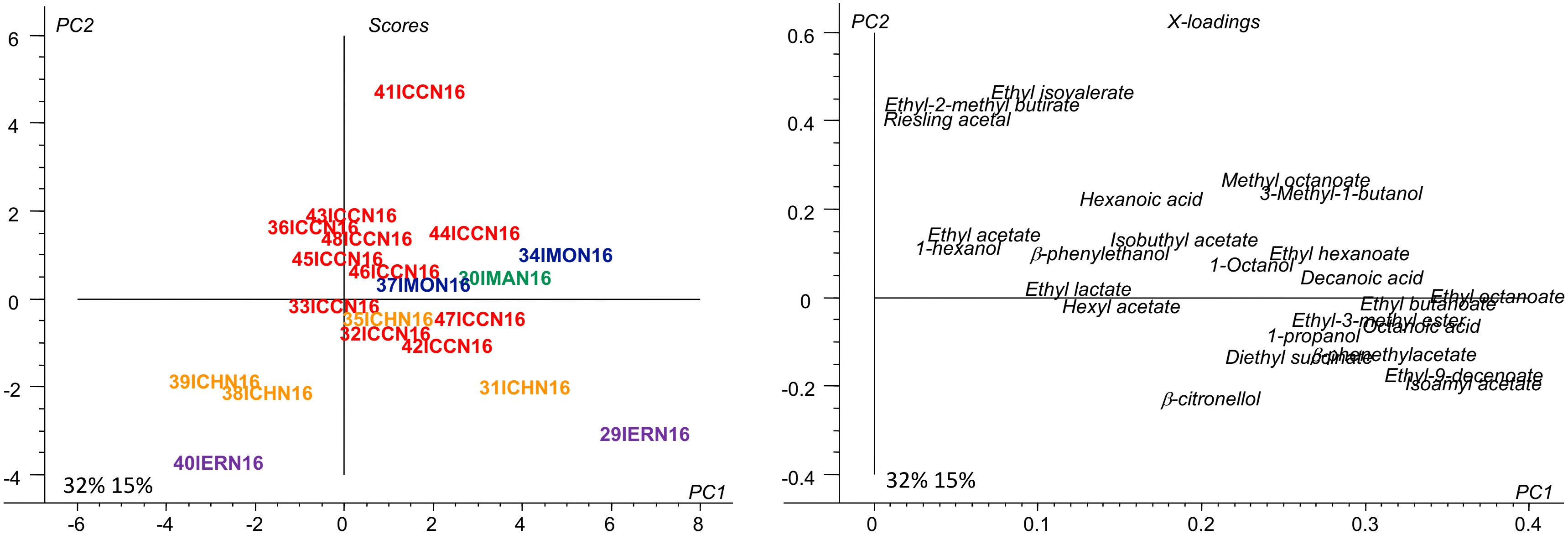
From the World: conversazioni sincrone con la Napa Valley

2016 vintage

Sangiovese wines aroma: Italy



CC Chianti Classico (Tuscany)
CH Chianti (Tuscany)
MA Maremma (Tuscany)
MO Montalcino (Tuscany)
ER Emilia Romagna

Scores and loadings

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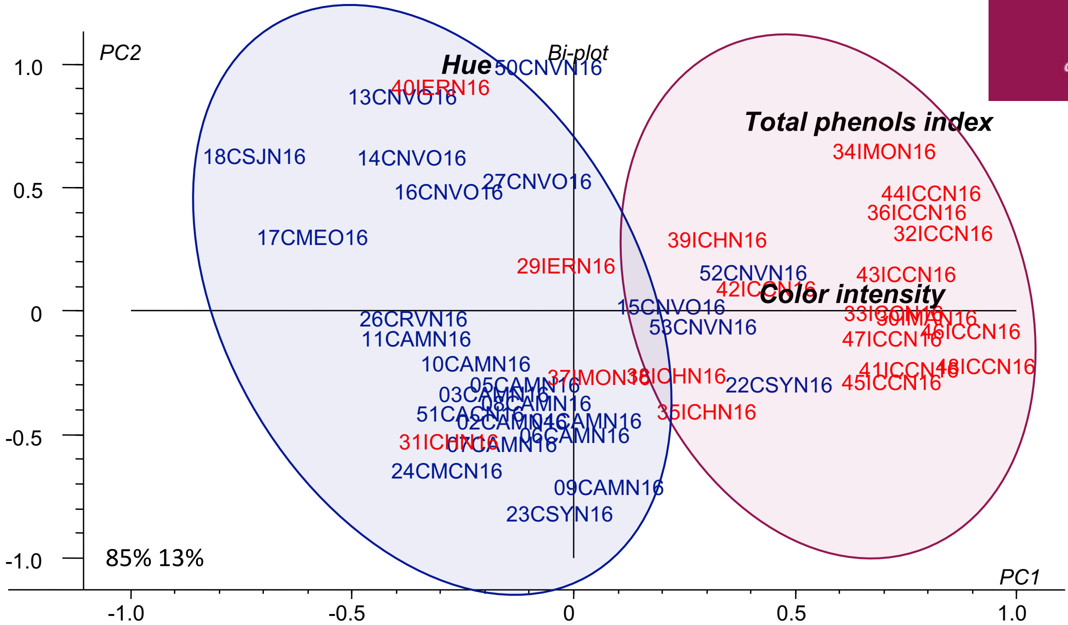
SANGUIS JOVIS

Valentina Canuti - 14 Luglio 2022

2016 vintage

Sangiovese wines color indices: California and Italy

California Italy



Scores and loadings

	Color intensity		Hue		Total phenols index	
min	6.771	8.593	0.602	0.444	31.880	36.622
25%	8.865	13.027	0.726	0.549	39.095	48.903
mean	9.803	18.882	0.792	0.585	39.373	58.550
75%	10.603	20.031	0.923	0.711	44.081	61.585
max	16.077	25.346	1.191	1.090	57.617	71.633
average	10.198	17.525	0.893	0.641	41.328	56.788
stdv	2.294	5.087	0.159	0.147	7.070	9.234

p-value ≤ 0.0000

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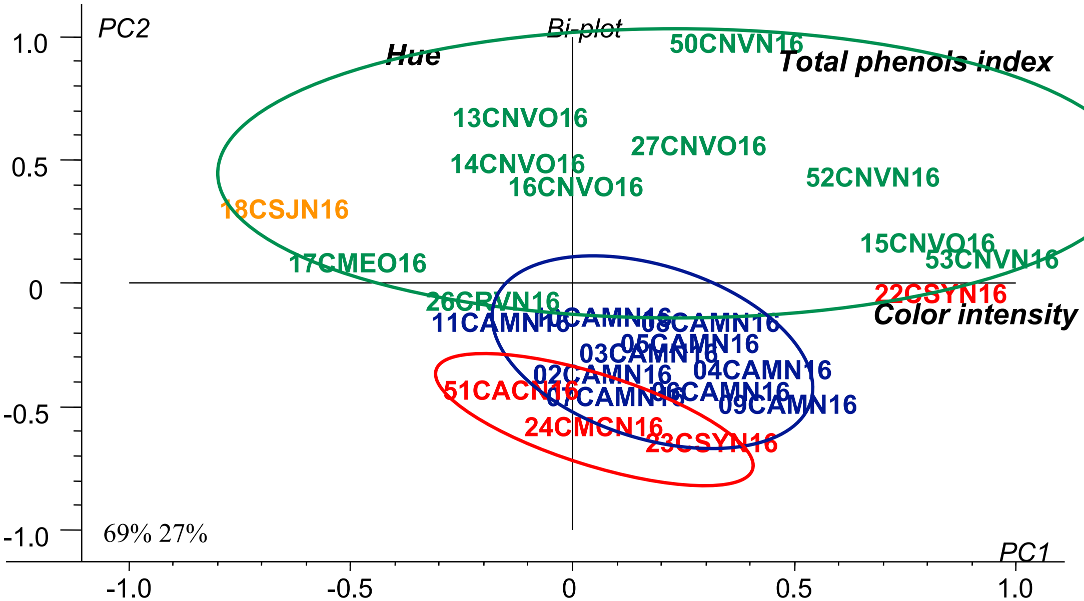
2016 vintage

Sangiovese wines color indices: California



MC Monterey County (Central Coast)
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RV Redwood Valley (North Coast)
SC Sonoma County (North Coast)
NV Napa Valley (North Coast)
ME Mendocino (North Coast)

Scores and loadings

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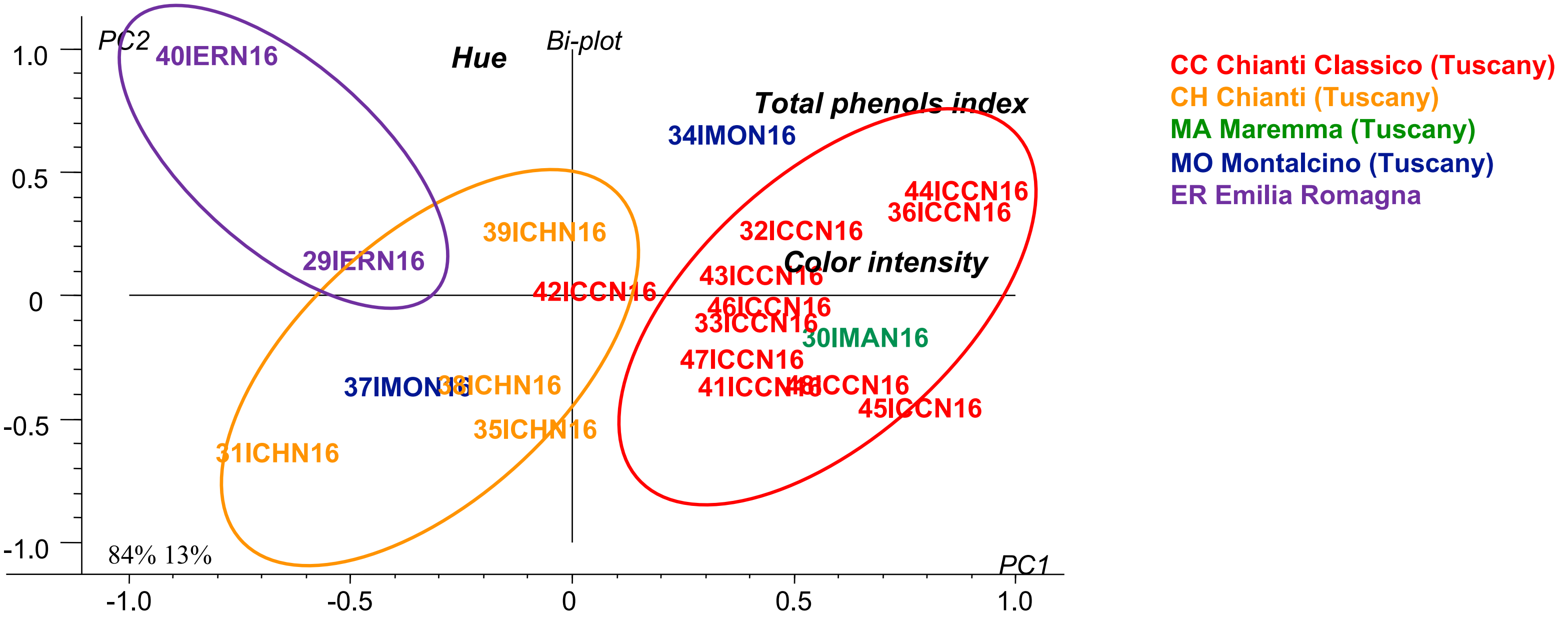
2016 vintage

Sangiovese wines color indices: Italy

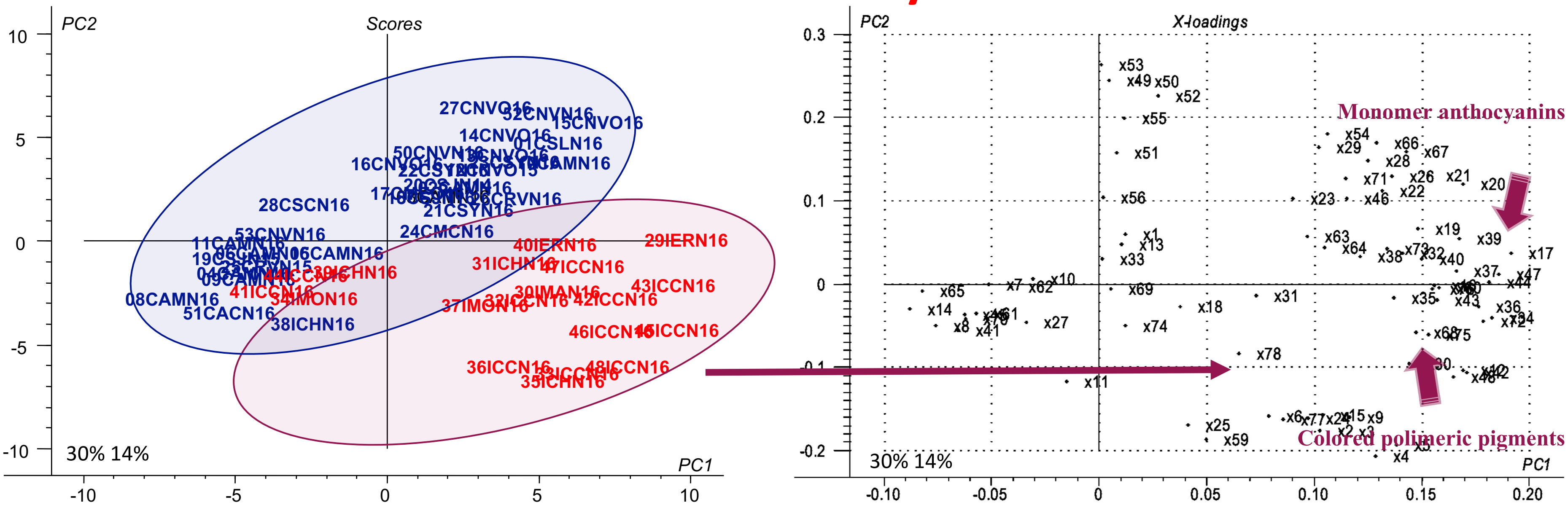


Scores and loadings

2016 vintage

Sangiovese wines LC q-TOF Analysis: California and Italy

California Italy



Phenolic composition of wines

Scores and loadings

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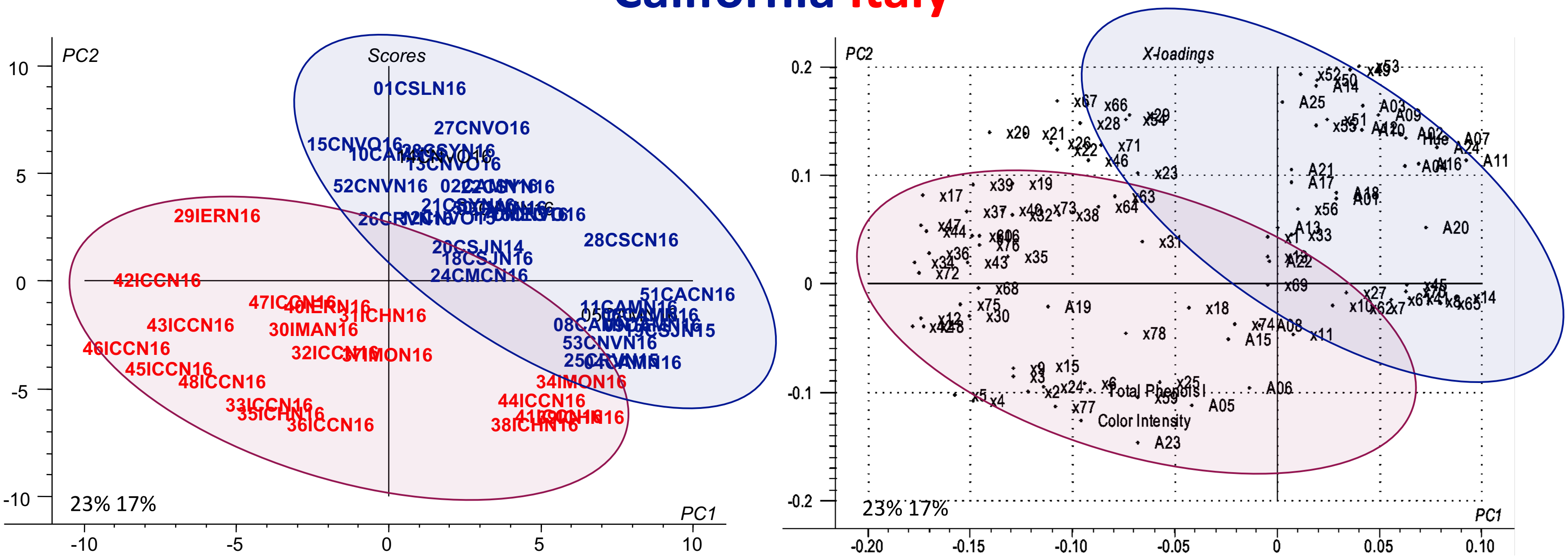
2016 vintage

Californian and Italian Sangiovese wines: all chemical parameters

California Italy



Scores and loadings

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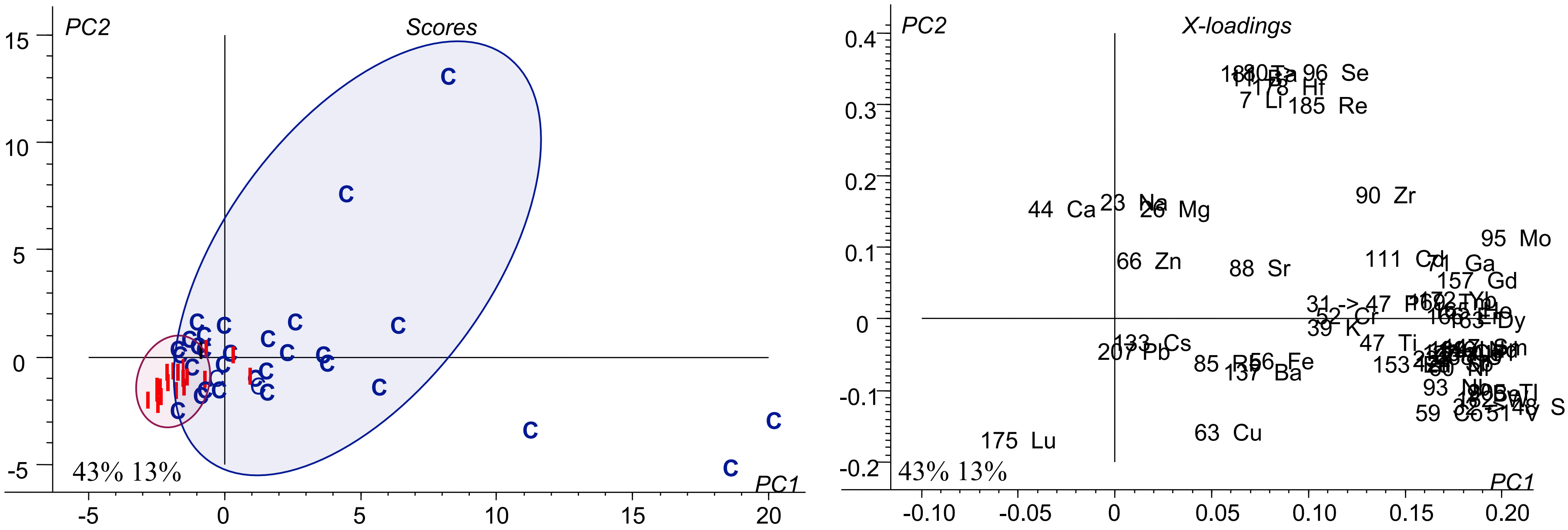
2016 vintage

Sangiovese wines elementals: California and Italy

Only significant elements (*p*-value ≤ 0.0000) were use for PCA



California Italy

Scores and loadings

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Results 2016 vintage

1. Chemical authentication: definition and comparison of Sangiovese wines from Italy and California
2. The Sangiovese identity: the expression of the variety in two different countries

Sangiovese wines: California *vs* Italy

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2016 vintage
Sangiovese italian wine model

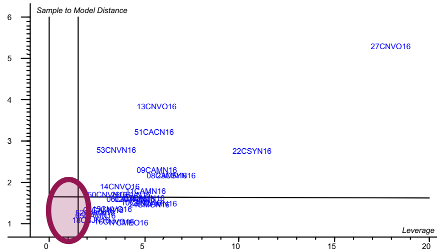
Principal Component Analysis (PCA) and the Soft Independent Modelling of Class Analogy (SIMCA) were performed using Unscrambler (V10.3, CAMO Process AS, Oslo, Norway).

The SIMCA analysis allows to assess which are the decisive factors that determine the classification. In fact, in this classification method, each class is described by an independent principal component analysis model.

New samples are classified on the basis of their fit with the different PCA models.

Italian Sangiovese wines

Californian Sangiovese wine model



Californian Sangiovese wines

From the World: conversazioni sincrone con la Napa Valley

2016 vintage
Sangiovese italian wine model: aroma e color indices

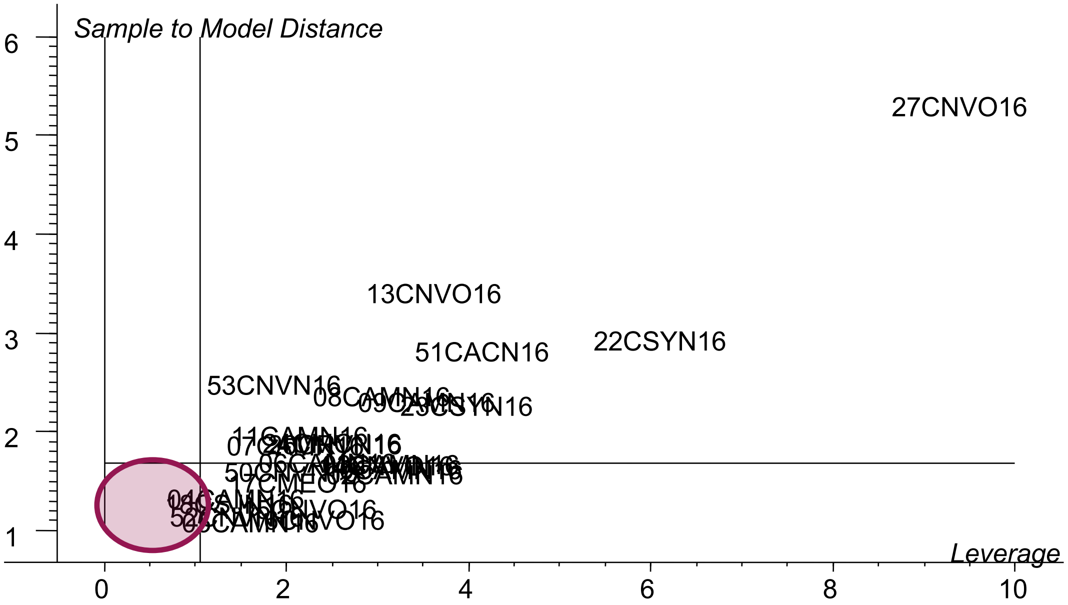


Table 6. Classification of the Sangiovese Italian Wines Using SIMCA as a Function of the Sangiovese Californian Wines (5% significance limit) and the Different Group of Variables for Model Development (all variables, volatiles, phenols, color indices, and elements)[a]

wine code	all variables	phenols	volatiles	color indices	elements
27IER	–	–	●	●	●
28IER	–	–	–	●	–
29IMA	–	–	●	–	–
30IMO	●	●	●	–	●
31IMO	●	–	●	●	–
32ICH	●	–	●	●	●
33ICH	–	–	●	●	–
34ICH	–	–	●	●	●
35ICH	–	●	–	●	–
36ICC	–	–	●	–	●
37ICC	–	–	●	–	–
38ICC	–	–	–	–	–
39ICC	●	●	–	–	●
40ICC	–	–	●	●	●
41ICC	–	–	●	–	●
42ICC	–	●	●	–	–
43ICC	–	–	●	–	–
44ICC	–	–	●	–	●
45ICC	–	–	●	–	●
46ICC	–	–	●	–	●

[a]The wines indicated with the symbol (●) fit the model, while (–) indicates Italian wines not fitting the model.

2016 vintage - Conclusions

The results of this study provide a definition and comparison of Sangiovese wines from Italy and California and in particular:

- It showed that for commercial fermentations it is possible to determine chemical regional differences for wines: regional differences in volatile and phenolic composition exist among Sangiovese wines with larger separation between country (Italy and California)

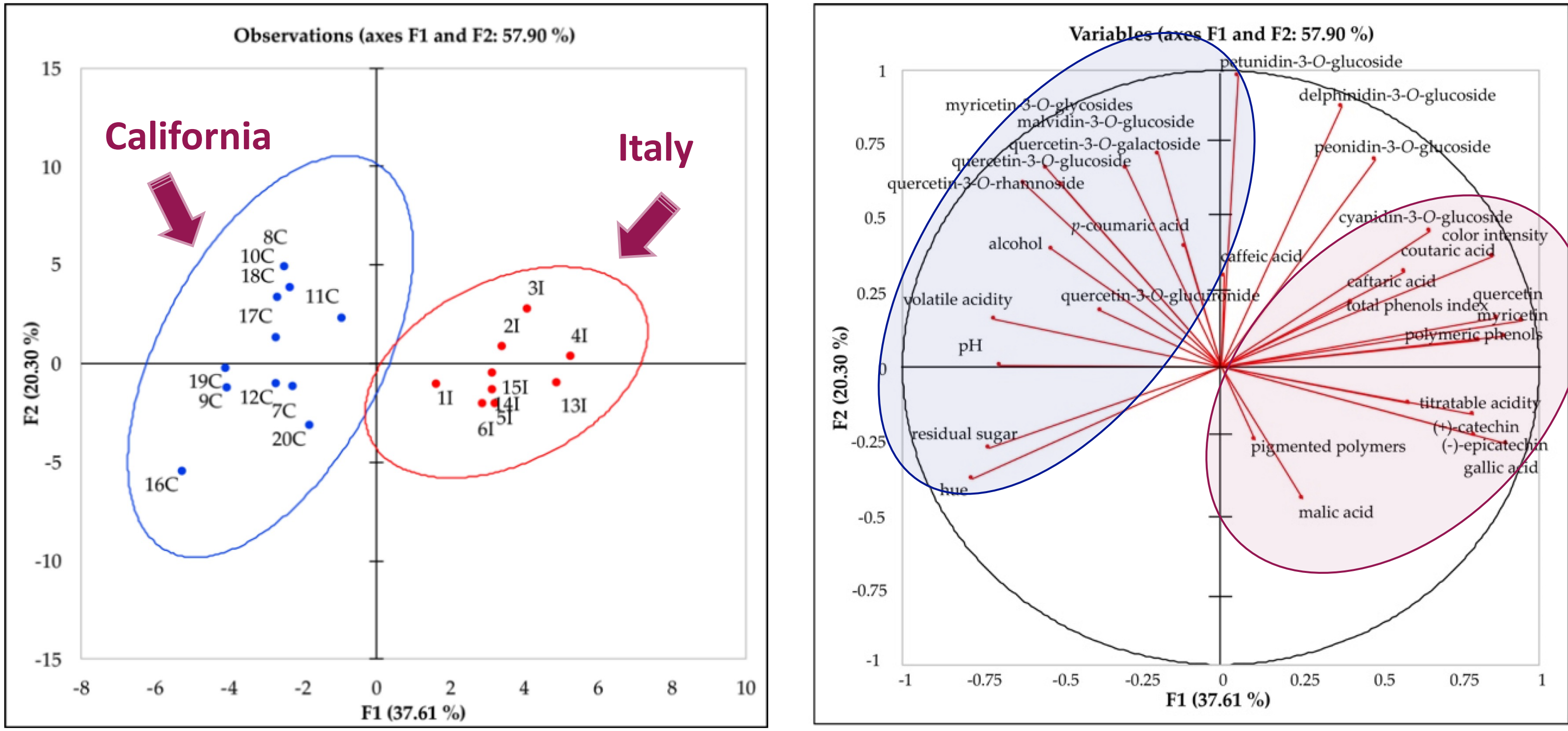
- There were similarity among the chemical composition of the Sangiovese wines regardless of the country of origin, indicating some inherent "identity" in the grape variety

- Four Italian wines fit the "Californian model": these wines have the same chemical characteristics of the Italian wines

- To our knowledge, this is the first time that an extensive regionality study has been attempted for Sangiovese wines.

- Repeat the study on 2017 harvest to confirm some results from the 2016 study
- Combine the chemical profiles of the wines with the sensory profiles
- Define the Sangiovese wine typicality by experts

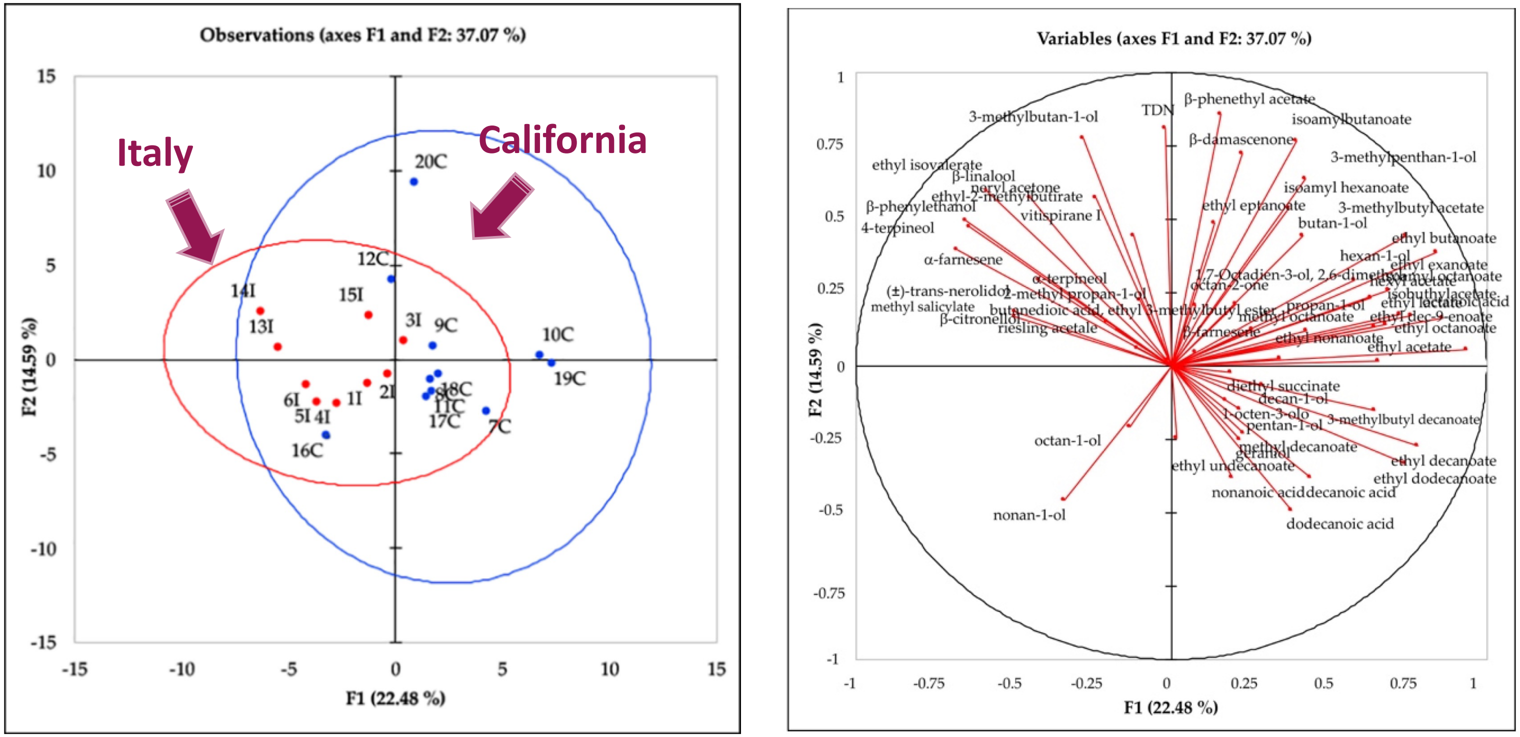
Results - 2017 vintage



(a) (b)

Figure 1. Principal component analysis (PCA) scores (**a**) and loadings (**b**) plots of eligibility profile (standard chemical parameters, color indices, and polyphenol compounds) for Sangiovese wines from Italy (in red) and California (in blue) from 2017 harvest. See Table 1 for the wine codes.

Results - 2017 vintage



(a) (b)

Figure 2. Principal component analysis (PCA) scores (**a**) and loadings (**b**) plots of identity profile (volatile compounds) for Sangiovese wines from Italy (in red) and California (in blue) from 2017 harvest. See Table 1 for the wine codes.

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Results - 2017 vintage

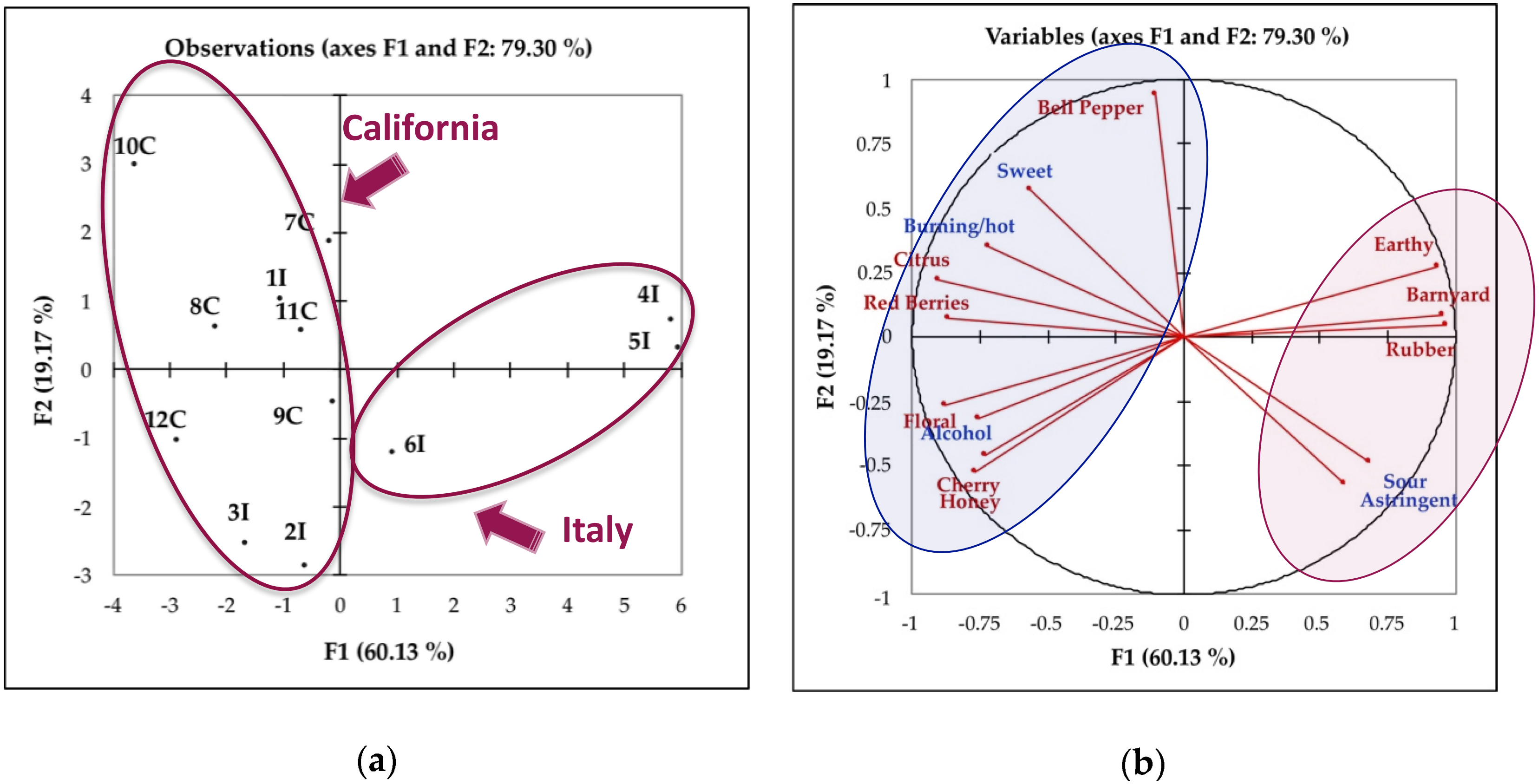
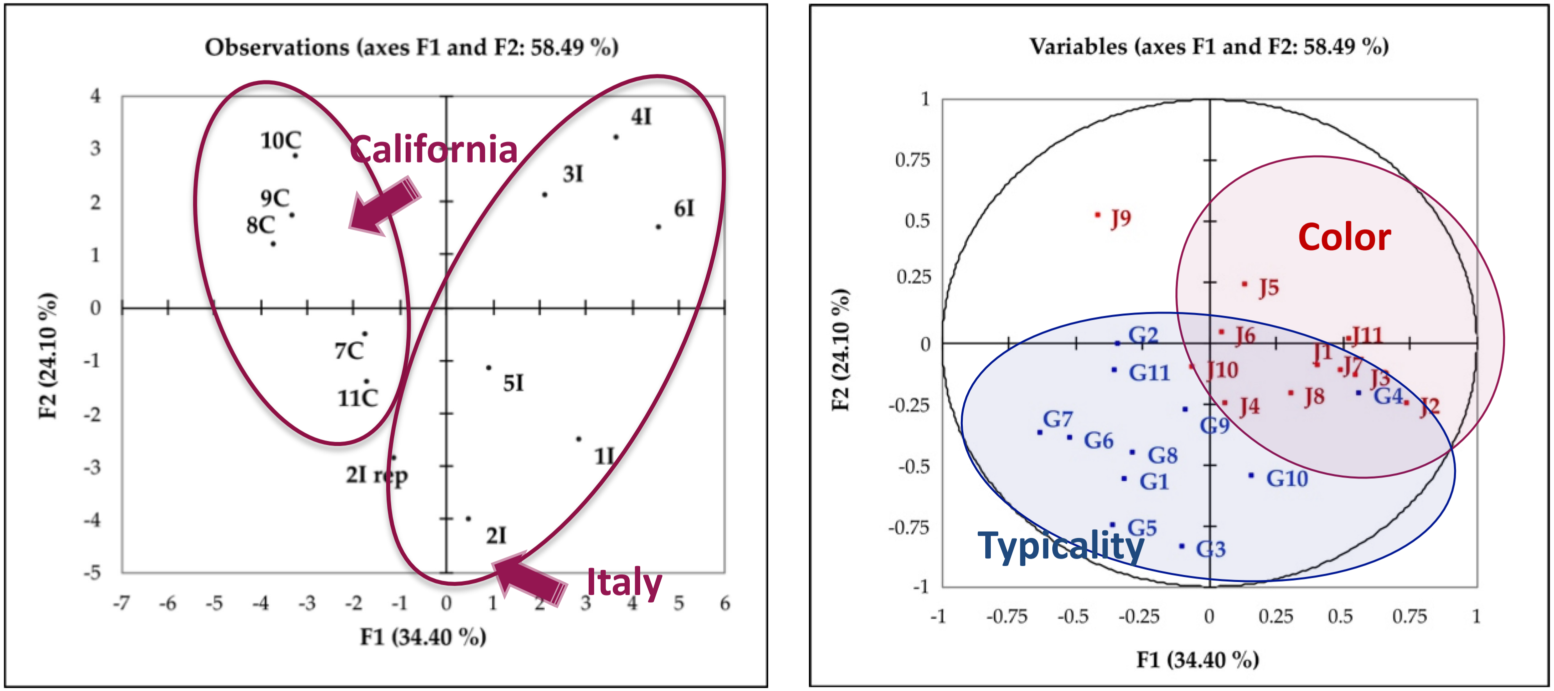


Figure 3. Principal component analysis (PCA) scores (**a**) and loadings (**b**) plots of eligibility (blue) and identity (red) profile (QDA sensory attributes) for Sangiovese wines from Italy and California from 2017 harvest. See Table 1 for the wine codes.

Results - 2017 vintage



(a) (b)

Figure 4. Representation of the Italian and Californian wines by multiple factor analysis according to the Napping X- and Y-coordinates, quality of color and typicality scores provided by the panel of experts. (**a**) Wines distribution (see Table 1 for wine codes); (**b**) distribution of the quality of color (j1–j11 in red) and typicality scores (G1–G11 in blue) (elaborated as supplementary data).

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SANGUIS JOVIS

Results - 2017 vintage

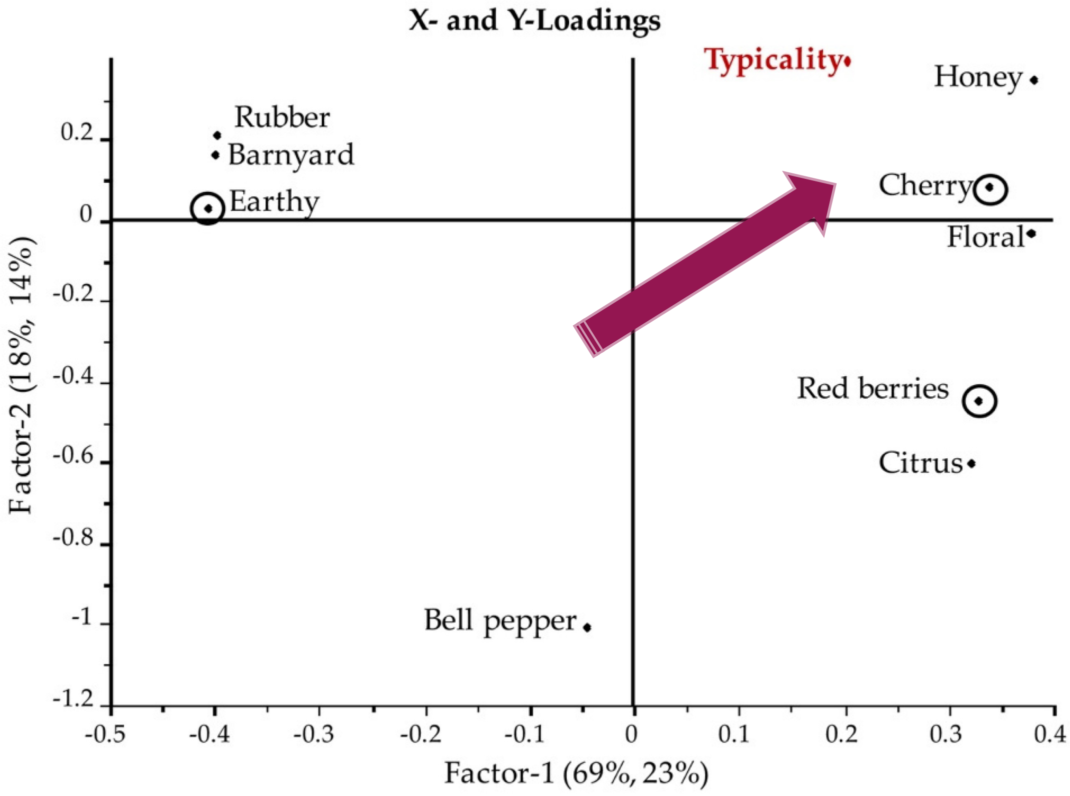

Figure 5. Partial least square regression (PLS-1) model for prediction of the typicality scores of wines by identity sensory attributes. Marked attributes with the circle around the dot were considered the important variables according to the uncertainty test (Earthy, Cherry, and Red berries).

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SANGUIS JOVIS

Results - 2017 vintage

Table 3. Typicality and Color scores of the Italian and Californian wines assigned by the experts' panel (mean values). See Table 1 for wine code, 2I rep is the replicates of the 2I wine [1].

Wine	Typicality Score	Color Score
1I	8.36 ab	3.45 d
2I	9.54 a	4.00 bcd
2I (replicate)	8.63 ab	4.73 ab
3I	8.09 bc	4.82 a
4I	6.73 cd	4.18 abcd
5I	8.00 bcd	4.18 abcd
6I	6.64 d	4.27 abcd
7C	8.36 ab	3.54 d
8C	8.27 ab	4.36 abc
9C	7.91 bcd	2.18 e
10C	7.45 bcd	3.54 d
11C	8.54 ab	3.91 cd
F-value sample	*2.51*	*5.72*
p-value sample	*0.0074*	*0.0000*
Standard error sample	*0.51*	*0.29*
Average Italian	*8.00 a*	*4.23 b*
Average Californian	*8.11 a*	*3.51 a*
F-value region	*0.93*	*5.27*
p-value region	*0.3370*	*0.0234*

[1] Different letters within the same row indicate significant differences.

2017 vintage - Conclusions

The results of this study provide a definition and comparison of Sangiovese wines from Italy and California and in particular:

- These results showed that the Sangiovese variety is recognizable even if grown abroad, very far from the original terroir of Italy and in particular in Tuscany. This is supported by the fact that the varietal volatiles were found in both wines from both countries, even if the Californian wines were more intense in fermentative volatiles than Italian wines were.

- The main differences seemed related more to the intrinsic quality in terms of eligibility chemical and sensory profiles. Important and significant differences were found in wines for the polyphenol composition since Italian wines were higher in color intensity, tannins, monomeric anthocyanins, and pigmented polymers content. Consequently, they were perceived more intense in color and astringency.

- On the other hand, Californian wines were higher in alcohol content and pH and lower in titratable acidity compared to the Italian wines. These results reflected the eligibility sensorial perception of the wines in which the Italian wines tend to be more acidic, less sweet, and more astringent than their Californian counterparts.

2017 vintage - Conclusions

The results of this study provide a definition and comparison of Sangiovese wines from Italy and California and in particular:

- Concerning the perceived quality, despite the Tuscan experts perceived differences between the Californian and Italian wines, they considered them similar when they evaluated their typicality.

- Finally, the results from this study confirm that perceived quality in terms of typicality of Sangiovese was still related not only to fruity and floral flavors but also to lightness and freshness, despite the intrinsic quality aspect of the "structure" of the wine and to what is considered a "good" color.

The findings confirm that Sangiovese shows a flexibility in terms of chemical and sensory modification, according to the production area and that it can be considered typical even if it comes from an area far away from the traditional ones.

Thanks to the UCDavis Viticulture and Enology staff and the wineries…in particular...

VITICULTURE & ENOLOGY
UNIVERSITY OF CALIFORNIA DAVIS

Susan E.Ebeler
Hildegard Heymann
Larry Lerno
Scott Frost
Courtney Tanabe
Carolyn Doyle
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