

### Supplemental Data for:

Casassa, L.F., C.W. Beaver, M. Mireles, R.C. Larsen, H. Hopfer, H. Heymann, and J.F. Harbertson. 2013. Influence of fruit maturity, maceration length, and ethanol amount on chemical and sensory properties of Merlot wines. *Am. J. Enol. Vitic.* 64:437-449. doi: 10.5344/ajev.2013.13059.

**Supplemental Table 1** Used reference standards for the aroma attributes in the descriptive analysis of Merlot wines of the 2011 season. All aroma references were prepared in Franzia Vinter's Select Burgundy unless otherwise noted.

Category	Reference	Anchor
<b>Artificial fruit</b>	¼ tsp Kool-aid (Kraft Foods, Glenview, IL) cherry flavor in 30 mL	low - high
<b>Black pepper</b>	3 crushed black pepper corns (McCormick, Hunt Valley, MD) in 30 mL	low - high
<b>Dried fruit</b>	2 halved prunes (Pacific Coast Selection, SafeMart, Modesto, CA), 19 g cut dates (Band Valley Natural Delights Medjool Dates, Yuma, AZ), 11.2 g cut banana in 10 mL	low - high
<b>Canned/ cooked veggie</b>	9 g sauerkraut (Sonoma Brinery, Healdsburg, CA), 5 mL whole milk (Crystal Creamery, Modesto, CA), 10 mL olive brine (Pitted Bistro Blend Olives marinated in herbs and Napa Valley Chardonnay, Mezzetta, American Canyon, CA), 5 mL canned green bean juice (Western Family, Tigard, OR), 7 mL canned cut asparagus juice (Sunny Select, SafeMart) in 10 mL	low - high
<b>Fresh veggie</b>		
Green beans	1 cut fresh green bean in 20 mL	low - high
Mint	0.3 g fresh spearmint in 20 mL	low - high
Straw/hay	0.5 g Natural's Café Alfalfa Hay Mini Bales (Davis, CA); no wine	low - high
<b>Fruit</b>	10 g cut Ganny Smith apple, 0.45 g orange peel, 0.3 g lime peel, 0.3 g lemon peel, 11.5 g cut peach; no wine	low - high
<b>Red berry</b>	1 medium cut strawberry, 2 medium cut raspberries; no wine	low - high
<b>Chemical</b>	1 mL ethyl acetate in 20 mL	low - high
<b>Alcoholic</b>	2 mL 200° proof ethanol (Goldshield, Hayward, CA) in 20 mL	low - high
<b>Chocolate/ caramel</b>	3.5 tsp caramel (Mrs. Richardson's Butterscotch, Frankfort, IL), 1 tsp 15.4 g extra dark chocolate (70% cacao Brix Chocolate) in 20 mL, 2 pinches ground cloves (McCormick), 0.5 mL vanilla extract (McCormick)	low - high
<b>Dark fruit</b>		
Cassis	2 mL back currant flavor (IFF)	low - high
Dark fruit	21.6 g cut plum, 2 tsp strawberry jam (Smucker's, Orrville, OH), 1 tsp raspberry preserve (Hero, Amsterdam, NY)	low - high
<b>Earthy</b>		
Fennel	5 pinches fennel seed (McCormick) in 10 mL	low - high
Musty	2 mL CE organic acid solution (Agilent, Santa Clara, CA) in 10 mL	low - high
Soil	1 cedarball (Cedar Fresh), 3 pinches American oak small chips medium toast (evoak, Oak Solutions, Napa, CA), 1 tbsp potting soil (Black Gold, Agawam, MA), 6 medium pieces orchid bark (Black Gold), 5 drops of water; no wine	low - high
<b>Floral</b>	0.5 g Hibiscus tea (Davidson's Te de Hibiscus, Reno, NV) in 10 mL hot water, 4 mL violet solution (2 drops violet essence in 100 mL water) in 10 mL	low - high
<b>Barnyard</b>	0.01 g ground white pepper (McCormick), 0.5 g dried horse manure with straw in 20 mL	low - high

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**Supplemental Table 2** Used reference standards for the taste and mouthfeel attributes in the descriptive analysis of Merlot wines of the 2011 season. All taste and mouthfeel standards were prepared in Arrowhead water (Nestlé Waters America, Stamford, CT).

Category	Reference	Anchor
Sweet	10 g/L sucrose (C & H, Crockett, CA)	low - high
Sour	1 g/L L-tartaric acid (Fisher Scientific, Waltham, MA)	low - high
Salty	3 g/L kosher salt (Morton's, Chicago, IL)	low - high
Bitter	0.8 g/L caffeine (Sigma-Aldrich, St. Louis, MO)	low - high
Astringent	0.8 g/L alum (McCormick, Hunts Valley, MD)	low - high
Hot	250 mL/L 40% (v/v) vodka	low - high
Viscous	1.5 g/L carboxymethyl cellulose (Sigma-Aldrich)	thin - thick

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**Supplemental Table 3** One-way ANOVA showing mean separation of basic wine analysis of Merlot wines produced from grapes harvested with two maturity levels and with two maceration treatments and two ethanol-adjustment (EtOH) procedures.

Season and harvest/skin contact <sup>a</sup>	EtOH <sup>b</sup>	pH	TA (g/L tartaric acid)	Alcohol (%v/v)	Malic acid (mg/L)	Lactic acid (g/L)	Acetic acid (g/L)	Glucose (g/L)	Fructose (g/L)	Glycerol (g/L)
<b>2011 early</b>										
Control	NB	3.64 e <sup>c</sup>	5.71 ab	12.06 c	64 c	0.97 ab	0.21 b	0.47 e	2.13 a	7.71 d
	CHAP	3.67 de	5.64 b	14.55 a	75 ab	0.87 bc	0.25 ab	0.54 de	1.85 c	8.70 bc
EM	NB	3.72 cd	5.81 a	11.71 d	70 bc	1.05 a	0.23 ab	0.62 d	1.99 b	7.51 d
	CHAP	3.74 bc	5.68 ab	14.64 a	79 a	0.83 c	0.28 a	0.54 de	1.68 d	9.04 b
<b>2011 late</b>										
Control	NB	3.76 abc	4.92 d	14.21 b	9 b	0.73 c	0.28 a	1.43 a	1.73 d	9.99 a
	WB	3.77 ab	5.14 c	12.06 c	8 d	0.76 c	0.25 ab	1.12 c	2.02 ab	8.56 c
EM	NB	3.79 a	4.77 e	14.41 ab	8 d	0.75 c	0.25 ab	1.32 ab	1.73 d	8.96 a
	WB	3.77 ab	4.86 de	12.01 cd	13 d	0.77 c	0.27 a	1.24 bc	2.01 b	8.84 bc
<i>p</i> value		<0.0001	<0.0001	<0.0001	<0.0001	0.001	0.317	<0.0001	<0.0001	<0.0001
<b>2012 early</b>										
Control	NB	3.21 e	6.36 b	11.09 f	17 a	0.93 ab	0.38 b	1.01 bc	2.19 a	8.18 c
	CHAP	3.25 e	6.19 b	14.11 c	30 a	1.22 a	0.38 b	0.94 bc	1.69 cd	9.37 b
EM	NB	3.35 d	6.32 b	11.32 e	11 a	1.13 ab	0.44 ab	1.06 b	1.79 c	7.64 c
	CHAP	3.25 e	6.63 a	14.26 bc	60 a	1.11 ab	0.43 ab	1.26 a	1.61 de	10.06 a
<b>2012 late</b>										
Control	NB	3.72 ab	4.99 d	14.41 b	13 a	0.91 ab	0.49 a	1.04 bc	1.49 e	9.16 b
	WB	3.63 c	5.28 c	11.77 d	17 a	0.73 b	0.43 ab	0.92 c	2.11 a	8.07 c
EM	NB	3.74 a	4.94 d	14.67 a	10 a	0.89 ab	0.45 ab	1.03 bc	1.30 f	9.46 ab
	WB	3.67 bc	5.37 c	11.79 d	73 a	0.85 ab	0.44 ab	0.98 bc	1.91 b	7.93 c
<i>p</i> value		<0.0001	<0.0001	<0.0001	0.447	0.433	0.309	0.002	<0.0001	<0.0001

<sup>a</sup>Skin contact: Control, 10-day contact; EM, extended maceration, 30-day contact.

<sup>b</sup>EtOH adjustment: NB, natural Brix; CHAP, chaptalized; WB, saignée followed by water-back.

<sup>c</sup>Analysis of variance to compare data: different letters within a column (within a single season) indicate significant differences for Fisher's LSD at  $p < 0.05$ .

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**Supplemental Table 4** One-way ANOVA showing mean separation of selected CIELab parameters at press and at day 120 of Merlot wines produced from grapes harvested with two maturity levels and with two maceration treatments and two ethanol-adjustment (EtOH) procedures.

Season and harvest/ skin contact <sup>a</sup>	EtOH <sup>b</sup>	Press			Day 120		
		Saturation	Hue	a*	Saturation	Hue	a*
<b>2011 early</b>							
Control	NB	52.14 b <sup>c</sup>	5.95 a	51.84 b	41.19 c	1.96 d	41.36 c
	CHAP	49.49 b	6.21 a	49.21 b	40.11 c	2.69 cd	41.39 c
EM	NB	51.99 b	5.11 a	51.77 b	35.28 d	6.94 a	36.02 d
	CHAP	50.30 b	5.73 a	50.04 b	34.27 d	7.32 a	34.99 d
<b>2011 late</b>							
Control	NB	60.89 a	2.35 b	60.78 a	59.26 a	2.20 d	58.47 a
	WB	60.42 a	1.73 b	60.39 a	60.41 a	1.76 d	60.37 a
EM	NB	61.31 a	2.74 b	61.27 b	54.90 b	4.27 b	54.78 b
	WB	60.48 a	2.75 b	62.73 a	54.69 b	3.66 bc	54.66 b
<i>p</i> value		<0.0001	0.001	<0.0001	<0.0001	<0.0001	<0.0001
<b>2012 early</b>							
Control	NB	60.16 c	1.04 ef	60.14 c	43.12 c	2.36 bc	43.09 f
	CHAP	58.28 d	2.04 de	58.24 d	44.85 c	2.90 b	44.84 ef
EM	NB	51.91 e	3.21 c	51.83 e	40.35 d	3.55 a	40.33 g
	CHAP	52.11 e	2.51 cd	52.05 e	36.77 e	3.89 a	45.09 e
<b>2012 late</b>							
Control	NB	62.71 b	0.81 f	62.35 b	59.20 a	1.53 d	58.14 b
	WB	64.61 a	0.84 f	64.07 a	60.25 a	2.16 c	60.08 a
EM	NB	50.67 f	5.10 b	50.67 f	51.60 b	2.61 bc	51.52 d
	WB	57.47 d	7.29 a	57.46 d	53.54 b	2.56 bc	53.52 c
<i>p</i> value		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

<sup>a</sup>Skin contact: Control, 10-day contact; EM, extended maceration, 30-day contact.

<sup>b</sup>EtOH adjustment : NB, natural Brix; CHAP, chaptalized; WB, saignée followed by water-back.

<sup>c</sup>Analysis of variance to compare data: different letters within a column (within a single season) indicate significant differences for Fisher's LSD at  $p < 0.05$ .

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**Supplemental Table 5** One-way ANOVA showing mean of the proportion of extracted tannins and skin/seed-derived tannins of Merlot wines produced from grapes harvested with two maturity levels and with two maceration treatments and two ethanol-adjustment (EtOH) procedures.

Season and harvest/ skin contact <sup>a</sup>	EtOH <sup>b</sup>	Total tannin (seed + skin) proportion (%)			Origin of tannins extracted into wine	
		Extracted	Recovered in pomace	Unaccounted	Skin-derived	Seed-derived
<b>2011 early</b>						
Control	NB	11 c <sup>c</sup>	70 a	19 d	42 a	58 c
	CHAP	12 bc	54 b	34 c	26 b	74 b
EM	NB	17 a	32 d	51 b	15 c	85 a
	CHAP	17 a	43 c	40 c	21 bc	79 ab
<b>2011 late</b>						
Control	NB	8 d	31 d	61 a	18 bc	82 ab
	WB	8 d	34 d	59 ab	19 bc	81 ab
EM	NB	14 b	27 d	59 ab	15 c	85 a
	WB	11 c	28 d	61 a	14 c	86 a
<i>p</i> value		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
<b>2012 early</b>						
Control	NB	10 d	62 ab	28 abc	34 a	66 c
	CHAP	12 d	66 a	23 c	38 a	62 c
EM	NB	15 c	53 cd	33 ab	25 c	75 a
	CHAP	13 cd	55 bcd	32 ab	28 bc	72 ab
<b>2012 late</b>						
Control	NB	19 b	56 bcd	25 bc	34 ab	66 bc
	WB	18 b	59 abc	23 c	37 a	63 c
EM	NB	22 a	44 e	34 a	24 c	76 a
	WB	18 b	48 de	33 ab	26 c	74 a
<i>p</i> value		<0.0001	0.001	0.034	<0.0001	<0.0001

<sup>a</sup>Skin contact: Control, 10-day contact; EM, extended maceration, 30-day contact.

<sup>b</sup>EtOH adjustment : NB, natural Brix; CHAP, chaptalized; WB, saignée followed by water-back.

<sup>c</sup>Analysis of variance to compare data: different letters in a column (within a single season) indicate significant differences for Fisher's LSD at  $p < 0.05$ .

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**Supplemental Table 6** Degrees of freedom (df) and F ratios from a three-way ANOVA of trained panel evaluation (n = 11) of Merlot wine sensory attributes. Evaluations were made along a 10-point line scale.

Source of variation	df	Aroma attributes													
		Alcoholic	Chemical	Fresh vegetable	Cooked vegetable	Earthy	Barnyard	Black pepper	Red berry	Fruit	Dark fruit	Dried fruit	Chocolate/caramel	Artificial fruit	Floral
Wine (W)	7	2.68** <sup>a</sup>	1.37	2.15*	2.93**	2.77*	3.60**	0.56	3.63*	0.70	0.70	0.55	2.99*	2.65*	2.63*
Panelist (P)	10	72.70***	74.38***	56.90***	78.58***	51.26***	39.03***	35.35***	56.66***	53.42***	67.77***	48.24***	55.19***	6.47***	30.25***
Replicate (R)	2	1.67	2.42	0.25	1.92	2.15	1.31	0.53	3.81*	1.11	0.46	0.63	0.48	2.31	0.26
P × W	70	1.30	1.00	0.96	2.19**	1.13	1.28	1.09	0.98	1.23	1.26	0.98	1.03	0.42	1.09
P × R	20	0.74	1.91**	1.07	0.91	1.01	0.84	1.40	0.68	0.34	0.87	0.59	0.61	0.51	0.60
W × R	21	2.29**	1.17	1.31	2.18**	1.36	2.04**	0.81	1.44	0.67	0.92	1.08	1.20	7.24***	1.13

<sup>a</sup>ANOVA to compare data: \*, \*\*, and \*\*\* indicate significance at  $p < 0.05$ ,  $p < 0.01$ , and  $p < 0.001$ , respectively.

**Supplemental Table 7** Degrees of freedom (df) and F ratios from a three-way ANOVA of trained panel evaluation (n = 11) of Merlot wine mouthfeel and color sensory attributes.

Source of variation	df	Taste and mouthfeel attributes <sup>a</sup>							Color attributes <sup>b</sup>		
		Sweet	Sour	Salty	Hot	Viscous	Astringent	Bitter	Lightness	Red	Yellow
Wine (W)	7	8.25*** <sup>c</sup>	7.91***	2.98*	17.11***	4.31***	5.55***	4.14***	38.34***	29.83***	33.80***
Panelist (P)	10	175.98***	99.31***	108.42***	100.50***	35.04***	80.18***	85.30***	22.56***	55.22***	29.59***
Replicate (R)	2	0.70	0.45	0.34	0.32	2.33	0.48	0.29	3.51	3.23	1.63
P × W	70	1.51**	1.21	1.01	1.44**	1.22	0.76	1.22	2.02***	1.36	1.16
P × R	20	0.41	0.28	0.75	0.90	0.67	0.56	1.21	9.08***	19.21***	13.15***
W × R	21	3.13***	3.44***	0.75	6.83***	2.29**	3.12***	2.53***	5.81***	4.89***	5.43***

<sup>a</sup>Evaluations made along a 10-point line scale.

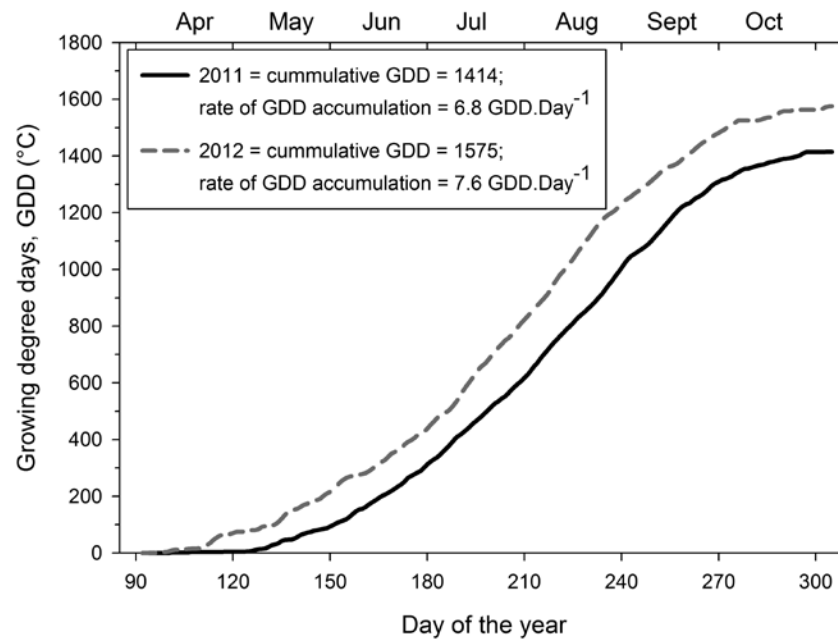
<sup>b</sup>Evaluations made by selecting the wine's most representative color in a wine color poster (*Les couleurs du vin*, Bouchard Aîné & Fils, Beaune, France) which was subsequently decoded in CIELab units.

<sup>c</sup>Analysis of variance to compare data: \*, \*\*, and \*\*\* indicate significance at  $p < 0.05$ ,  $p < 0.01$ , and  $p < 0.001$ , respectively.

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**Supplemental Figure 1** Growing degree day accumulation (base 10°C) in Paterson, WA, from 1 Apr to 31 Oct during the 2011 and 2012 growing seasons. Source: WSU AgWeatherNet (weather.wsu.edu).