

SUPPLEMENTARY MATERIAL

Table S1. Mean and standard deviation (Mean \pm SD), and minimum (Min) and maximum (Max) of Ca, Fe, Mg, Na, P and Rb determined in Freisa wines from Asti (FA), Chieri (FC), Colli Tortonesi (CTF), Langhe (LF) and Monferrato (MF) sites. All values are expressed in mg/L.

Site		Ca	Fe	Mg	Na	P	Rb
FA	Mean \pm SD	49 ^a \pm 9	1.9 ^b \pm 0.5	54 ^a \pm 5	6 ^a \pm 2	143 ^a \pm 30	2.2 ^{ab} \pm 0.5
	Min – Max	28 – 67	1.3 – 3.1	49 – 67	4 – 13	95 – 202	1.3 – 3.1
FC	Mean \pm SD	47 ^a \pm 7	1.9 ^b \pm 0.6	52 ^a \pm 6	6 ^a \pm 3	124 ^{ab} \pm 24	2.5 ^{ab} \pm 0.5
	Min – Max	34 – 57	1.2 – 3.2	44 – 63	3 – 12	101 – 177	1.9 – 3.7
CTF	Mean \pm SD	41 ^a \pm 9	4 ^a \pm 4	54 ^a \pm 11	12 ^a \pm 10	100 ^b \pm 25	1.7 ^c \pm 0.7
	Min – Max	30 – 51	2 – 12	41 – 72	5 – 25	72 – 131	0.9 – 2.6
LF	Mean \pm SD	47 ^a \pm 11	1.7 ^b \pm 0.3	53 ^a \pm 8	8 ^a \pm 6	139 ^a \pm 34	2.2 ^{bc} \pm 0.3
	Min – Max	33 – 75	1.3 – 2.2	45 – 77	2 – 25	71 – 189	1.6 – 2.7
MF	Mean \pm SD	45 ^a \pm 4	1.9 ^b \pm 0.3	54 ^a \pm 6	9 ^a \pm 12	128 ^{ab} \pm 26	2.6 ^a \pm 0.7
	Min – Max	41 – 56	1.6 – 2.5	44 – 60	3 – 42	80 – 156	1.9 – 4.0
<i>F</i>		n.s.	3.433 *	n.s.	n.s.	2.786 *	3.575 *

*** Significant for $p < 0.001$; ** Significant for $p < 0.01$; * Significant for $p < 0.05$; ° Significant for $p < 0.1$; n.s.: not significant. F: calculated Fischer's F. Data followed by different letters in the same column are significantly different (LSD test at $p \leq 0.05$).

Table S2. Mean and standard deviation (Mean \pm SD), and minimum (Min) and maximum (Max) of Al, Ba, Cr, Cu and Mn determined in Freisa wines from Asti (FA), Chieri (FC), Colli Tortonesi (CTF), Langhe (LF) and Monferrato (MF) sites. All values are expressed in $\mu\text{g/L}$.

Site		Al	Ba	Cr	Cu	Mn
FA	Mean \pm SD	426 ^a \pm 170	61 ^{ab} \pm 19	139 ^b \pm 13	439 ^a \pm 133	614 ^a \pm 135
	Min – Max	175 – 676	29 – 93	122 – 167	270 – 720	392 – 930
FC	Mean \pm SD	360 ^{ab} \pm 169	58 ^{ab} \pm 16	137 ^b \pm 9	423 ^a \pm 117	603 ^a \pm 138
	Min – Max	112 – 624	24 – 71	122 – 148	223 – 592	360 – 830
CTF	Mean \pm SD	363 ^{ab} \pm 170	54 ^{ab} \pm 22	151 ^a \pm 5	361 ^a \pm 77	392 ^b \pm 246
	Min – Max	173 – 551	27 – 79	144 – 159	290 – 479	192 – 856
LF	Mean \pm SD	258 ^b \pm 70	49 ^b \pm 13	144 ^{ab} \pm 6	438 ^a \pm 151	564 ^{ab} \pm 182
	Min – Max	151 – 379	28 – 74	133 – 157	274 – 710	338 – 995
MF	Mean \pm SD	325 ^{ab} \pm 161	72 ^a \pm 29	150 ^a \pm 7	350 ^a \pm 73	604 ^a \pm 221
	Min – Max	149 – 589	41 – 128	143 – 160	280 – 495	328 – 882
<i>F</i>		2.253 [°]	n.s.	4.207 **	n.s.	n.s.

*** Significant for $p < 0.001$; ** Significant for $p < 0.01$; * Significant for $p < 0.05$; [°] Significant for $p < 0.1$; n.s.: not significant. F: calculated Fischer's F. Data followed by different letters in the same column are significantly different (LSD test at $p \leq 0.05$).

Table S3. Mean and standard deviation (Mean \pm SD), and minimum (Min) and maximum (Max) of Ni, Sr, Ti and Zn determined in Freisa wines from Asti (FA), Chieri (FC), Colli Tortonesi (CTF), Langhe (LF) and Monferrato (MF) sites. All values are expressed in $\mu\text{g/L}$.

Site		Ni	Sr	Ti	Zn
FA	Mean \pm SD	118 ^a \pm 9	258 ^{bc} \pm 70	8.6 ^a \pm 3.1	244 ^a \pm 131
	Min – Max	102 – 138	171 – 373	4.6 – 14.8	46 – 467
FC	Mean \pm SD	120 ^a \pm 12	193 ^c \pm 70	7.2 ^a \pm 1.7	245 ^a \pm 151
	Min – Max	106 – 137	71 – 327	5.0 – 9.8	45 – 537
CTF	Mean \pm SD	124 ^a \pm 19	811 ^a \pm 215	20.0 ^a \pm 25.0	318 ^a \pm 144
	Min – Max	106 – 159	491 – 1117	5.8 – 70.0	89 – 530
LF	Mean \pm SD	121 ^a \pm 9	280 ^{bc} \pm 94	11.7 ^a \pm 15.9	312 ^a \pm 147
	Min – Max	104 – 133	154 – 447	4.4 – 63.5	70 – 622
MF	Mean \pm SD	125 ^a \pm 15	327 ^b \pm 164	14.8 ^a \pm 11.5	91 ^b \pm 74
	Min – Max	112 – 161	145 – 667	5.5 – 38.5	30 – 229
<i>F</i>		n.s.	29.224 ***	n.s.	4.287 **

*** Significant for $p < 0.001$; ** Significant for $p < 0.01$; * Significant for $p < 0.05$; ° Significant for $p < 0.1$; n.s.: not significant. F: calculated Fischer's F. Data followed by different letters in the same column are significantly different (LSD test at $p \leq 0.05$).

Table S4: Element concentrations in Freisa wines from our study and in other red wines from other Italian regions.

		Our study Freisa (Piedmont) (n=55)	Bronzi et al. (2020) Chianti (Tuscany) (n=125)	Blotevogel et al. (2019) DOP Chianti (Tuscany) (n=2)	Blotevogel et al. (2019) Red wine from Tuscany (n=3)	Blotevogel et al. (2019) Red wine from Liguria (n=3)	Monaci et al., (2003) Chianti Classico (Tuscany) (n=13)	Monaci et al., (2003) Chianti (Tuscany) (n=13)	Monaci et al., (2003) Cabernet S. (Veneto) (n=13)
Element	Unit	Mean (min - max)	min - max	Mean (min - max)	Mean (min - max)	Mean (min - max)	Mean	Mean	Mean
Al	µg L ⁻¹	346 (112 – 676)					380	360	220
Ba	µg L ⁻¹	58 (24 – 128)	120 – 240	191 (53 – 329)	80 (30 – 140)	100 (48 – 173)	110	80	100
Ca	mg L ⁻¹	46 (28 – 75)		71 (65 – 76)	69 (51 – 87)	63 (54 – 73)	87.5	85.9	106
Cr	µg L ⁻¹	143 (122 – 167)					12.0	12.4	17.5
Cu	µg L ⁻¹	411 (222 – 720)					170	210	40
Fe	mg L ⁻¹	2.1 (1.2 – 12.5)	0.98 – 1.37				4.93	3.41	2.68
Mg	mg L ⁻¹	53 (41 – 77)	99.1 – 101	108 (95 – 121)	99 (56 – 141)	96 (93 – 102)	93.3	79.9	69.4
Mn	mg L ⁻¹	0.6 (0.2 – 1.0)	0.86 – 0.94	0.85 (0.64 – 1.06)	0.93 (0.80 – 1.14)	0.94 (0.58 – 1.36)	0.86	0.75	1.01
Na	mg L ⁻¹	8 (2 – 42)	11.3 – 12.3				9.18	10.4	6.95
Ni	µg L ⁻¹	121 (102 – 161)	9.28 – 16.0				27.7	29.3	20.6
P	mg L ⁻¹	131 (71 – 202)					150	151	100
Rb	mg L ⁻¹	2.3 (0.9 – 4.0)	2.85 – 3.22						
Sr	mg L ⁻¹	0.33 (0.07 – 1.12)	0.53 – 0.67	0.70 (0.70 – 0.71)	0.54 (0.36 – 0.77)	0.77 (0.52 – 0.91)	0.43	0.48	0.80
Ti	µg L ⁻¹	11.6 (4.4 – 69.1)	13.6 – 14.3				20.1	10.6	9.20
Zn	µg L ⁻¹	243 (30 – 622)					580	690	6100

		Our study Freisa (Piedmont) (n=55)	Potorti et al. (2016) Nero d'Avola (Sicily) (n=39)	Potorti et al. (2016) Syrah (Sicily) (n=34)	Marengo et al. (2003) Red wine from Piedmont (n=68)	Galgano et al. (2008) Red wine (Basilicata) (n=40)	Galgano et al. (2008) Red wine (Calabria) (n=40)	Galgano et al. (2008) Red wine (Campania) (n=40)
Element	Unit	Mean (min - max)	Mean (min - max)	Mean (min - max)	min - max	Mean	Mean	Mean
Al	µg L ⁻¹	346 (112 – 676)			210 – 1,770	893	1,550	1,260
Ba	µg L ⁻¹	58 (24 – 128)				176	123	188
Ca	mg L ⁻¹	46 (28 – 75)	124 (68 – 217)	110 (75 – 163)	30 – 90	83.17	73.32	70.27
Cr	µg L ⁻¹	143 (122 – 167)	35 (10 – 106)	18 (10 – 30)	20 – 50	16.98	19.68	14.67
Cu	µg L ⁻¹	411 (222 – 720)	289 (121 – 1,525)	744 (139 – 1,820)	1 – 1,340	150	249	95.86
Fe	mg L ⁻¹	2.1 (1.2 – 12.5)	4.7 (1.0 – 9.4)	4.7 (2.4 – 9.6)	1.35 – 27.8	3.91	3.92	2.60
Mg	mg L ⁻¹	53 (41 – 77)	122 (100 – 152)	159 (126 – 224)	70 – 115	102.35	116.70	88.25
Mn	mg L ⁻¹	0.6 (0.2 – 1.0)	1.3 (0.5 – 1.9)	1.2 (0.7 – 1.8)	0.67 – 2.50	1.63	1.53	1.04
Na	mg L ⁻¹	8 (2 – 42)	41 (10 – 205)	37 (11 – 101)	3.4 – 200	20.97	28.47	18.70
Ni	µg L ⁻¹	121 (102 – 161)	67 (17 – 203)	28 (10 – 53)	15 – 210	40.55	54.57	35.72
P	mg L ⁻¹	131 (71 – 202)			280 – 630	171	193	162
Rb	mg L ⁻¹	2.3 (0.9 – 4.0)			0.6 – 2.3	2.29	2.18	3.79
Sr	mg L ⁻¹	0.33 (0.07 – 1.12)			0.32 – 2.40	1.34	1.86	1.11
Ti	µg L ⁻¹	11.6 (4.4 – 69.1)			0.10 – 0.55	20.41	27.27	20.31
Zn	µg L ⁻¹	243 (30 – 622)	6,607 (3,801 – 11,793)	3,571 (1,234 – 6,571)	135 – 4,800	560	720	600