Relationships between the Fregoni bioclimatic index (IF) and wine quality

Relations entre l'index bioclimatique Fregoni (IF) et la qualité du vin

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Summary

The Fregoni bioclimatic index (IF) considers the daily temperature range during the ripening month and the number of days with temperature below 10°C. The world areas characterized by large daily temperature ranges produce, as a rule, great wines, like for example Napa and Sonoma valleys in California, Chile and the Cape province in South Africa. A worldwide survey was carried out in order to assess correlations between the IF and the wine quality. The wine quality, for the same wine type during different vintage years, was expressed as hedonic evaluation (by a score up to 100). Spain, Switzerland, Germany, Romania, Canada, Chile and South Africa were investigated. The IF (vintages 2000-2005) ranged from 300 to 4,000 in the Valencia region, while in Navarra (vintages 1996-2005) from 300 to 3,400. In Germany the IF (vintages 1996-2005) ranged from 300 to 6,500, in Switzerland from 1,300 to 10,800, in Romania (vintages 1990 – 2005) from 200 to 7,000, in Canada (vintages 1996-2005) from 300 to 2,000, in Chile (vintages from 1999 to 2004) from 7,600 to 16,200, in South Africa (vintages 1994-2002) from 260 to 470. In cool climate countries like Germany and Switzerland, the best vintages corresponded to intermediate IF values (2,000-3,000, in Germany, and 5,000-6,000 in Switzerland), while in a warmer country like South Africa the best vintages corresponded, as a rule, to the highest IF (400).

Keywords: temperature, ripening, wine quality, climate.

Introduction

The most utilized bioclimatic indices in viticulture such as the Winkler index (heat summation as degree-days) and Huglin index, express the energetic aspect of the climate, since they are considering the temperatures above 10 °C during the vine growth season. These indices are useful to characterize vine growing regions and to assess the capability of different grape varieties to well adapt (in terms of ripening) to a particular environment, but they are unsuitable to predict the grape (and wine) quality. A climatic classification system for grape-growing regions worldwide has recently been released (Tonietto and Carbonneau, 2004). Grape quality is correlated, beside other factors, to the temperature daily range during the ripening time (veraison-harvest), because it affects sugars, anthocyanins and aromas accumulation. It is well known that the most elegant aromatic compounds are found in wines from temperate areas, with a high temperature daily range during the ripening time, such as Chile, Napa Valley, Sonoma County, Monterey (California), Cape province (South Africa), many European areas, etc. During the day the vine is making the photosynthesis, while during the night the photosynthesis products move from the source leaves to the fruit. The Fregoni bioclimatic Index (IF) considers September, in the northern hemisphere, and March in the southern hemisphere, as ripening time. Moreover it accounts not only for the daily temperature range, but also for the number of days with temperature below 10 °C; the ideal approach should be to calculate the number of hours below 10 °C, but it is difficult to have those data. Taking into account these aspects Fregoni developed a bioclimatic index (IF) as follows (Fregoni and Pezzutto, 2000):

$$\sum_{i=1/IX}^{30/IX} (T\max_i - T\min_i) \cdot (n°dd < 10°C)$$

According to the literature, the IF ranges from 200 to 20,000 and the best qualitative results are achievable at intermediate levels, being too low or too high values unsuitable for giving the proper balance among the qualitative parameters.
The optimum and minimum IF values depend on the rainfall and other factors. The maximum IF value should be assessed , since above certain levels the effect of IF enhancement is weak.
Another index emphasizing the role of the daily temperature range in grape quality is the Cool night index (Tonietto, 1999).
The aim of this trial is to correlate the wine quality of different vintages all over the world with the corresponding calculated IF, following previous investigations carried out in Italy, Spain and Chile (Fregoni and Pezzutto, 2000; Fregoni, 2005).

Material and methods

The following viticultural areas worldwide have been considered for the trial: Alicante and Navarra (Spain), Valais (Switzerland), Rheinland-Pfalz (Germany), Niagara Peninsula (Canada), Romania, Santiago region (Chile), Cape province (South Africa); the geographical references and the wines are reported in Table 1. In each of those the IF has been calculated and, where available, the wine quality as hedonic evaluation was assessed (by a score up to 100), along a period ranging from 6 to 15 years.

Viticultural area	Geographical references	Wines and vintage year
Chile		
Pirique	Lat. 33° 40' S Long. 70° 40' W	Cabernet Sauvignon, Carménère 1999-2004
South Africa - Stellenbosch		
Nietvoorbij	Lat. 33° 91' 68" S Long. 18° 85' 99" E 148 m a.s.l.	Cabernet Sauvignon, Sauvignon blanc, Chardonnay 1996-2002
Middlevlei	Lat. 33° 55' 47" S Long. 18° 50' 06" E 148 m a.s.l.	Cabernet Sauvignon, Sauvignon blanc, Chardonnay 1994-2002
Thelema	Lat. 33° 90' 27" S Long. 18° 91' 96" E 413 m a.s.l.	Cabernet Sauvignon, Sauvignon blanc, Chardonnay 1994-2002
Grootvlei	Lat. 33° 54' 43" S Long. 18° 49' 55" E 210 m a.s.l.	Cabernet Sauvignon, Sauvignon blanc, Chardonnay 1996-2002
Skoonheid	Lat. 33° 57' 18" S Long. 18° 44' 05" E 250 m a.s.l.	Cabernet Sauvignon, Sauvignon blanc, Chardonnay 1994-2002
Goedehoop	Lat. 33° 91' 52" S Long. 18° 75' 91" E 235 m a.s.l.	Cabernet Sauvignon, Sauvignon blanc, Chardonnay 1995-2002
Klein Bottelary	Lat. 33° 53' 40" S Long. 18° 44' 28" E 110 m a.s.l.	Cabernet Sauvignon, Sauvignon blanc 1995-2002
Jakobsdal	Lat. 33° 96' 61" S Long. 18° 72' 83" E 130 m a.s.l.	Cabernet Sauvignon, Sauvignon blanc, Chardonnay 1995-2002
Alto	Lat. 34° 01' 41" S Long. 18° 85' 59" E 250 m a.s.l.	Cabernet Sauvignon, Chardonnay 1995-2002
Rustenhof	Lat. 34° 04' 49" S Long. 18° 78' 91" E 56 m a.s.l.	Cabernet Sauvignon, Sauvignon blanc, Chardonnay 1995-2002
Meerlust	Lat. 34° 00' 57" S Long. 18° 45' 15" E 27 m a.s.l.	Cabernet Sauvignon, Sauvignon blanc, Chardonnay 1995-2002
Bonfoi	Lat. 33° 93' 52" S Long. 18° 78' 04" E 143 m a.s.l.	Cabernet Sauvignon, Sauvignon blanc, Chardonnay 1995-2002
Le Bonheur	Lat. 33° 82' 93" S Long. 18° 86' 83" E 255 m a.s.l.	Cabernet Sauvignon, Sauvignon blanc, Chardonnay 1995-2002
Elsenburg	Lat. 33° 85' 24" S Long. 18° 83' 06" E 175 m a.s.l.	Cabernet Sauvignon, Sauvignon blanc, Chardonnay 1996-2002

Table 1South hemisphere: geographical references, wines and vintage year considered in the study

Viticultural area	Geographical references	Wines and vintage year
Spain		
Turis	Lat. 39° 24' 02" N Long. 0° 41' 01" W 299 m a.s.l.	D.O. Valencia: Garnacha tinta 2000-2005
Villana	Lat. 38° 35' 48" N Long. 0° 52' 24" W 495 m a.s.l.	D.O. Alicante: Monastrell 2000-2005
Requena	Lat. 39° 29' 00" N Long. 1° 06' 00" W 692 m a.s.l.	D.O. Utiel-Requena: Bobal 2000-2005
Olite Navarra	Lat. 42° 28' 53" N Long. 1° 39' 06" W 389 m a.s.l.	Tempranillo, Cabernet Sauvignon, Merlot 1996-2005
Switzerland		
Sion	Lat. 46° 14' N Long. 7° 21' E 490 m a.s.l.	Chasselas, Sylvaner, Petit Arvine, Pinot noir, Gamay, Cornalin 1996-2005
Germany		
Geilweilerhof	Lat. 49° 13' N Long. 08° 03' E 195 m a.s.l.	Riesling, Muller-Thürgau, Sylvaner, Pinot noir, Regent 1996-2005
Romania		
Bucarest-Pietroasa Meteo station n°502608		Tămâioasă românească, Italian Riesling, Merlot, Cabernet Sauvignon, Busuioacă de Bohotin 1990-2005
Canada		
Vineland	Lat. 43° 15' N Long. 79° 41' W 110 m a.s.l.	1996-2005

Table 2 North hemisphere: geographical references, wines and vintage year considered in the study

Results and Discussion

Spain

The IF, calculated over 6 years (2000-2005) in Valencia region, ranged from 323 to 4,090 and the correlation with the wine quality varied depending on the wines (Figure1).

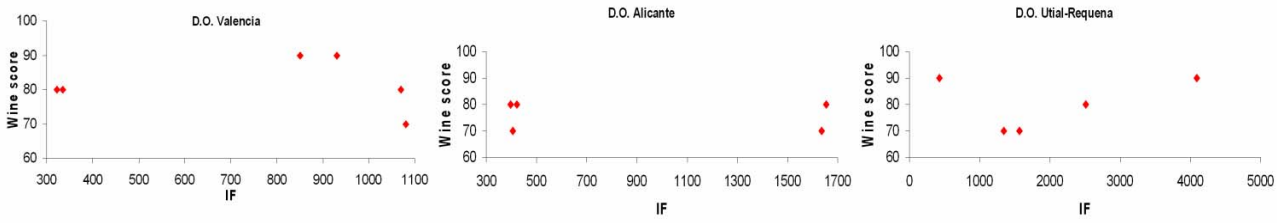

Figure 1 IF calculated over 6 years (2000-2005) in Valencia region, Spain.

The IF, calculated over 10 years (1996-2005) in Navarra (Olite) region, ranged from 294 to 3,368, and the correlations with the wine quality score was positive (Figure 2).

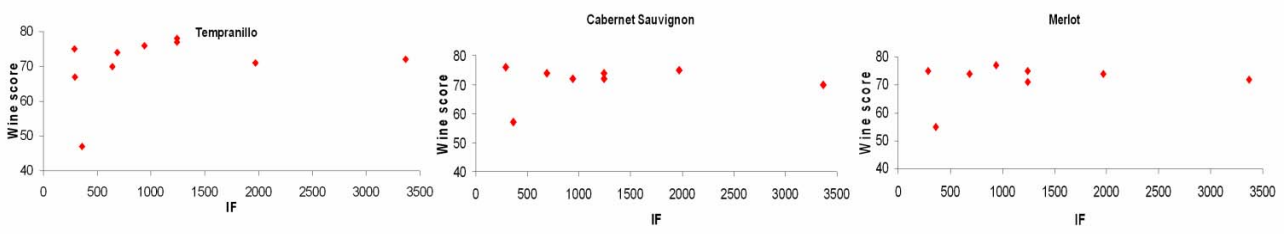

Figure 2 IF calculated over 10 years (1996-2005) in Navarra (Olite), Spain.

Switzerland

The IF, calculated over 10 years (1996-2005) in Sion (Valais), ranged from 1,325 to 10,811, and the relation with the wine quality (average value of all the corresponding wines) did not show any particular trend (Figure 3)

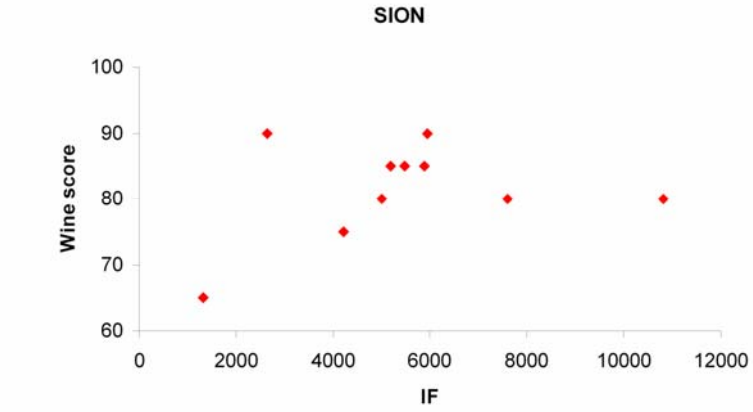

Figure 3 IF calculated over 10 years (1996-2005) in Sion (Valais), Switzerland

Germany

The IF, calculated over 10 years (1996-2005) in Rheinland –Pfalz region, ranged fro 323 to 6,545, and it seems to be a positive correlation with Riesling, Müller Thurgau and Silvaner wine quality and a negative one with Pinot noir and Regent (Figure 4).

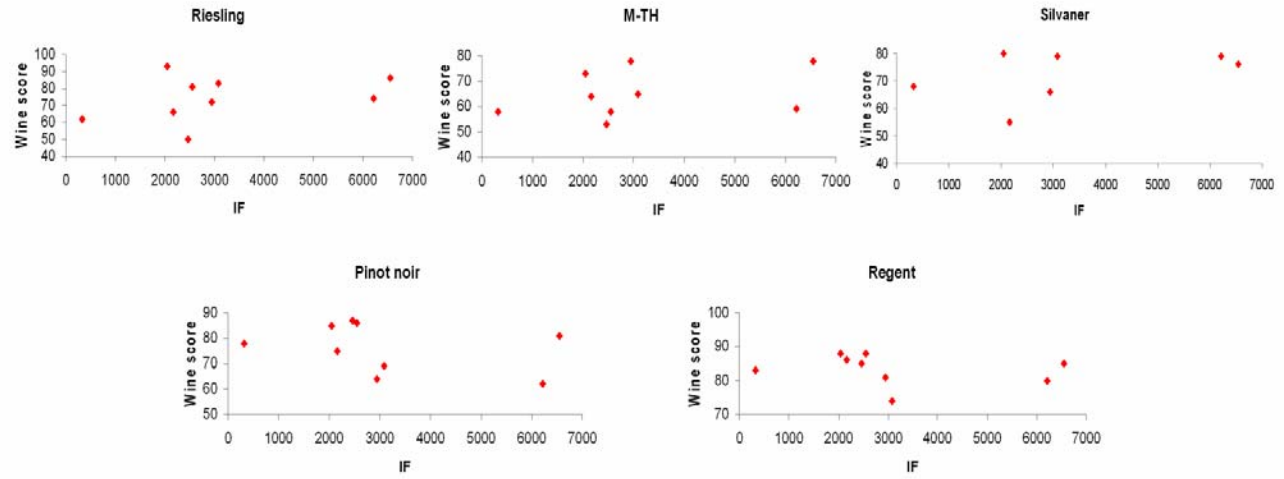

Figure 4 IF calculated over 10 years (1996-2005) in Rheinland-Pflaz region, Germany.

Romania

A wide IF range (209 to 7,076) occurred in the Bucharest region, over a 16-year-period (1990-2005), but unfortunately a complete wine quality score was not available. Table 3 represents the IF values and the vintage years when the wine quality was judged the best.

	'90	'91	'92	'93	'94	'95	'96	'97	'98	'99	'00	'01	'02	'03	'04	'05
IF	3014	1839	2726	3110	209	4462	6565	7076	1657	294	5948	4398	3418	2456	3372	1502
T.R.									X				X	X	X	
I.R.									X				X	X	X	
M.											X				X	
C.S.											X				X	
B.B.											X			X	X	

Table 3 IF values over 16 years (1990-2006) in the Bucharest region, Romania
T.R.:Tămâioasă românească; I. R.: Italian Riesling; M.: Merlot; C.S.: Cabernet Sauvignon; B.B.: Busuoioacă de Bohotin

Canada

Only IF was available, over a 10-year-period (1996-2005) in Vineland, ranging from 312 (2002) to 2025 (2003).

Chile

Only IF was available, over a 6-year-period (1999-2004) in Santiago region, ranging from 7,615 (2001) to 16,219 (2004)

South Africa

Many growing areas (14), nearby Stellenbosh were considered, over a 9-year-period (1994-2002), and the IF ranged from 264 to 474. The following tables are reporting IF and wine quality score.

NIETVOORBIJ

Year	I.F.	CAB SAU	SAU BLANC	CH
1996	334	59	42	48
1997	360	47	56	55
1998	329	61	46	43
1999	409	63	62	59
2000	313	50	51	56
2001	378	52	55	56
2002	391	49	47	60

MIDDLEVLEI

Year	I.F.	CAB SAU	SAU BLANC	CH
1994	378			
1995	419			
1996	400	62	58	
1997	406	46	51	49
1998	393	41	52	
1999	474	50	56	55
2000	381	54	56	49
2001	419		48	42
2002	437		43	51

LE BONHEUR

Year	I.F.	CAB SAU	SAU BLANC	CH
1995	292			
1996	295	46	50	52
1997	313	55	56	34
1998	282	60	40	46
1999	313	65	56	60
2000	264	54	46	41
2001	322	64	49	44
2002	316	51	53	59

MEERLUST

Year	I.F.	CAB SAU	SAU BLANC	CH
1995	391			
1996	372	24	46	52
1997	360	30		51
1998	338	55	40	50
1999	403	58	62	50
2000	329	55	52	53
2001	363	54	45	51
2002	372	36	53	

GROOTVLEI

Year	I.F.	CAB SAU	SAU BLANC	CH
1996	366	57	56	57
1997	375	51	57	49
1998	353	56	39	47
1999	431	61	58	59
2000	353	56	49	45
2001	406	61	49	59
2002	388		50	58

ALTO

Year	I.F.	CAB SAU	SAU BLANC
1995	372		
1996	310		52
1997	344		51
1998	322		45
1999	360	58	
2000	344	54	
2001	403	58	
2002	378	35	

KLEIN BOTTELARY

Year	I.F.	CAB SAU	SAU BLANC
1995	406		
1996	391	42	49
1997	372	54	60
1998	366	42	43
1999	437	54	51
2000		42	37
2001		53	46
2002		46	50

SKOONHEID

Year	I.F.	CAB SAU	SAU BLANC	CH
1994	316			
1995	341			
1996	313	61	57	46
1997	363	61	68	
1998	310	62	48	56
1999	344		66	
2000	307	63	46	46
2001	338	66	46	54
2002	326	51	58	50

THELEMA

Year	I.F.	CAB SAU	SAU BLANC	CH
1994	322			
1995	381			
1996	378	57	59	
1997	381	61	59	43
1998	344	54	53	56
1999	394	47	59	64
2000	310	49	54	55
2001	350	54	48	56
2002	350	54	61	63

ELSENBURG

Year	I.F.	CAB SAU	SAU BLANC	CH
1996		41	57	53
1997	406	56	46	53
1998	391	45		54
1999	459	37	58	56
2000	397	54	44	53
2001	419	36	54	55

JAKOBSDAL

Year	I.F.	CAB SAU	SAU BLANC	CH
1995	350			
1996	313	49	55	61
1997	319	64	59	44
1998	307	57	55	44
1999	353	60		63
2000	326	61	51	53
2001	338	61	45	54
2002	332	58	51	59

RUSTENHOF

Year	I.F.	CAB SAU	SAU BLANC	CH
1995	378			
1996	353	38	47	47
1997	353	60	54	43
1998	335	52	41	44
1999	397	50	58	65
2000	332	43	54	38
2001	347	40	45	49
2002	363	43	60	50

BONFOI

Year	I.F.	CAB SAU	SAU BLANC	CH
1995	369			
1996	326	26	62	49
1997	326	48	50	61
1998	316	40	41	43
1999	357	43	59	62
2000	316	49	50	55
2001	338	50	51	
2002	316	51	52	57

GOEDEHOOP

Year	I.F.	CAB SAU	SAU BLANC	CH
1995	329			
1996	301	44	56	44
1997	304	60	39	35
1998	288	49	41	47
1999	326	54	58	51
2000	301	55	48	40
2001	319	57	41	58
2002	304			

Conclusion

In cool climate countries like Germany and Switzerland, the best vintages corresponded to intermediate IF values (2,000-3,000, in Germany, and 5,000-6,000 in Switzerland), while in a warmer country like South Africa the best vintages corresponded, as a rule, to the highest IF (400).

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References

FREGONI C., and PEZZUTTO S. (2000) Principes et premières approches de l'indice bioclimatique de qualité de Fregoni. *Progrès Agricole et Viticole* **117** (18), 390-396.

TONIETTO J., and CARBONNEAU A**.** (2004) A multicriteria climatic classification system for grape-growing regions worldwide. *Agricultural and Forest Meteorology* **124**, 81-97.

TONIETTO J. (1999) Les macroclimats viticoles mondiaux et l'influence du mésoclimat sur la tipicité de la Syrah et du muscat de Hambourg dans le sud de la France : methodologie de caracterisation. These de Doctorat. Ecole Nationale Superiore Agronomique, Montpellier.