Climate influence on the grapevine phenology and anthocyanins content in wines from the Skopje vineyard area, Republic of Macedonia

Influence du climat sur la phénologie de la vigne et la concentration en anthocyanes des vins dans la région de Skopje, République de Macédoine

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Summary

The phenological stages and the content of the anthocyanins of non-irrigated cultivars Blatina, Vranec, Kratoshija, Prokupec and Stanushina were study. The cultivars are located in the Skopje vineyard area. The all examinated cultivars belong to the ecogeographical group of *convarietas Pontica, subconvariates balcanica* Negr.
The influence of climate was assessed with temperatures sum, sunshine hours and rainfall from the period 2001 to 2004.
The effect of climate and cultivar were found to be highly significant with regard to the vine behavior (phenological stages) and quality of the wine (content of anthocyanins).

Key words: vitis vinifera, climate, phenology, anthocyanins

Introduction

Grapevines are grown in different climate region that provide specific conditions to produce grapes and wine with high quality. The climate has the great influence on the grapevine development. For the best development the *vinifera* grape requires long, warm-to-hot, dry summer and cool winter. Climate influences the rates of change in the constituents of the fruit during development and the composition at maturity. Moderately cool weather, under which ripening proceeds slowly, is favorable for the production of dry table wines of quality. In very hot region growth and ripening changes proceed with great rapidity. The temperature is the only factor of climate that proved to be of predominant importance (Winkler et al. 1974).
Vitis vinifera grapevines are a phenologically distinct crop with the most important developmental stages being budburst, flowering (floraison), veraison, and harvest (grape maturity). The time between these phenological stages varies greatly with grapevine variety, climate and geographic location (Gregory et al., 2000). More important than the actual date of each phenological event is the interval between events (duration of phenological stages), which gives an indication of the overall climate during those period. Short intervals are associated with optimum conditions that facilitate rapid physiological growth and differentiation. Long intervals between events indicate less than ideal climate conditions and a delay in growth and maturation (Calò et al. 1997).

Materials and methods

In the Skopje vineyard region phenological observation have been done. The phenology and composition observation are made for the five following cultivars: Blatina, Vranec, Kratoshija, Prokupec and Stanushina. The all examinated cultivars belong to the ecogeographical group of

convarietas Pontica, subconvariates balcanica Negr. These cultivars give a red wine with different quality.
The phenological data are for the averages dates of budburst, flowering, veraison and harvest for 2001 to 2004. During the 2002 the winter frost extreme damaged the vines and because of that this year is excluded.
The budburst, floraison (flowering) and veraison (color change) events are considered to occur when, for a given cultivars, 50% of the vines are exhibiting the physiological response. Harvest date is recorded due to the optimum sugar level. The duration of each phenological stage, expressed in the number of days, for each cultivar is calculated.
Climate data used in this analysis are from UHMR (Hydrometeorological Service)-Skopje. These general climate parameters were used to derive other variables commonly used in viticulture studies in the region: average annual temperature, temperature sum, precipitation sum and insolation (table 1).

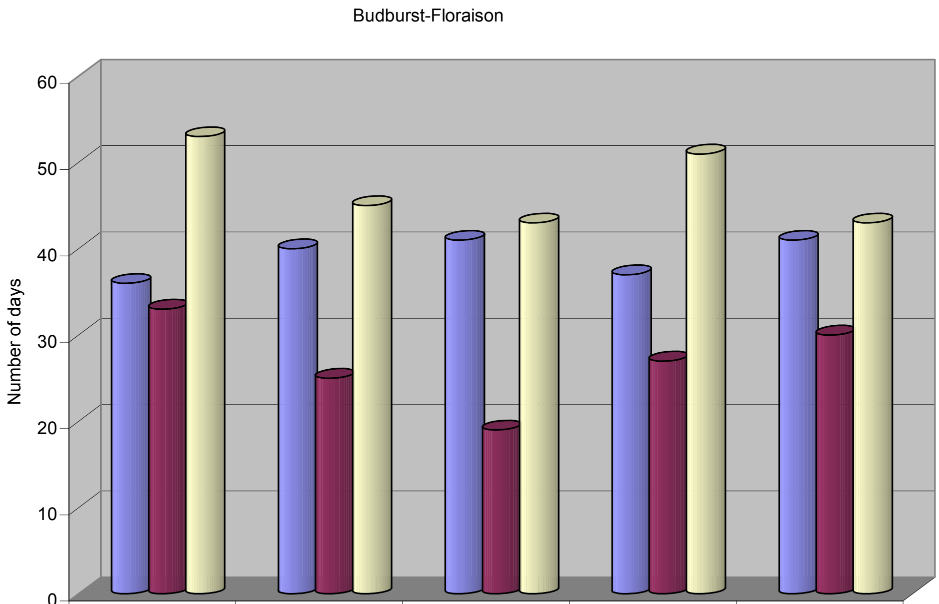
Element	2001	2003	2004	2001/2004
Average annual temperature (^oC)	13.4	12.9	12.8	13.0
Average vegetation temperature (^oC)	19.7	19.4	18.7	19.2
Annual temperature sum (^oC)	4912	4923	4693	4843
Temperature sum during vegetation (^oC)	4241	4328	4010	4193
Annual precipitation sum (mm)	298	497	532	442
Precipitation sum during vegetation (mm)	193	313	321	275
Annual insolation (h)	2351	2341	2293	2328
Insolation during vegetation (h)	1863	1801	1653	1772

Table 1Climate data

The content of anthocyanins in the wine is determined by Somers and Evans (Somers et al. 1979).

Results and Discussion

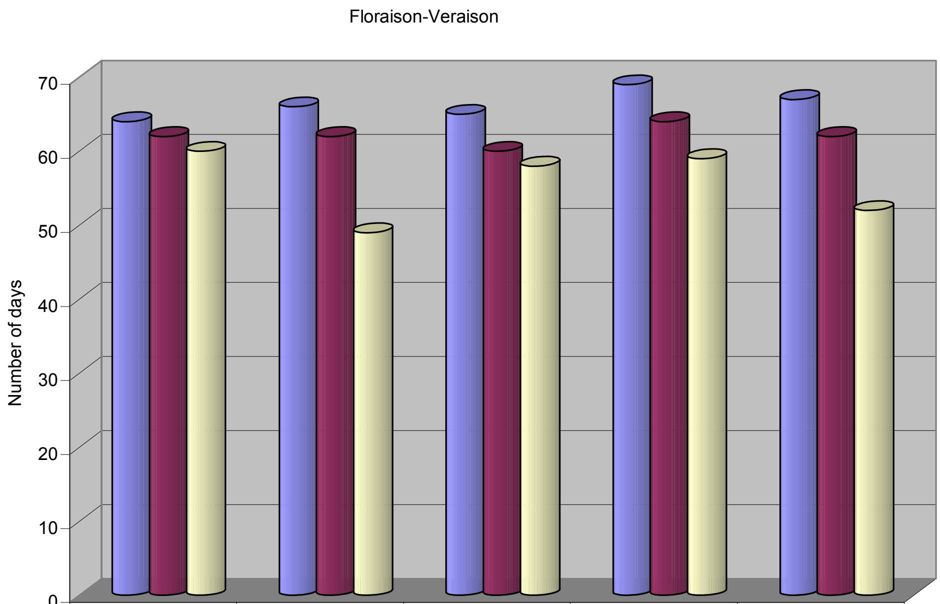
The duration of each phenological stage is determinate of cultivar and also of the climate conditions. More important than the actual date of each phenological event is the interval between events, which gives an indication of the overall climate during those periods
The temperatures sum during interval budburst to flowering (April-May) vary from 879^oC (2004), 924^oC (2001) to 944^oC (2003). The precipitation sum during this interval is from 99 mm (2004), 116 mm (2003) to 125 mm (2001). The longest duration of this interval (average 47 days) is in 2004 at each cultivar, when the temperature sum for April and May is the lowest (879^oC). The shortest duration (average 27 days) is in 2003 when the temperature sum is the highest (944^oC).(Fig. 1)



	Blatina	Vranec	Kratoshija	Prokupec	Stanushina
2001 (924 oC)	36	40	41	37	41
2003 (944 oC)	33	25	19	27	30
2004 (879 oC)	53	45	43	51	43

Figure 1 Interval budburst – flowering (days) in correlation with temperatures sum (^oC)

The temperatures sum during interval flowering to veraison (June-July) vary from 1386^{o}C (2004), 1439^{o}C (2001) to 1495^{o}C (2003). The precipitation sum during this interval is from 21 mm (2001), 64 mm (2003) to 116 mm (2004).

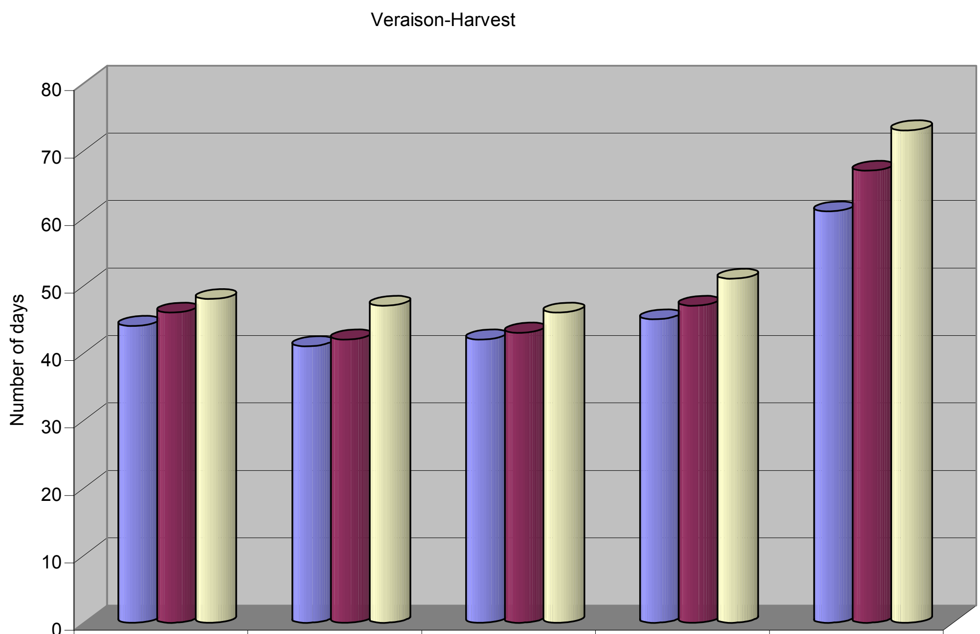


	Blatina	Vranec	Kratoshija	Prokupec	Stanushina
2001 (1439 oC)	64	66	65	69	67
2003 (1495 oC)	62	62	60	64	62
2004 (1386 oC)	60	49	58	59	52

Figure 2 Interval flowering – veraison (days) in correlation with temperatures sum (^oC)

The longest duration of this interval (average 66 days) is in 2001 at each cultivar, beside the temperature sum for June and July is the highest (1495^{o}C). In this interval the precipitation sum is the lowest, only 21 mm.

The shortest duration (average 56 days) is in 2004 when the temperature sum is the lowest (1386°C), but the precipitation sum is highest (116 mm).
This is mean that for this phenological stage, for grapevine growing and developing, beside the optimum temperatures sum, the optimum of precipitation sum is necessary. In this period the deficit of water delay the grapevine growth. (Fig. 2.)
The temperatures sum during interval veraison to harvest (August-September) vary from 1277°C (2004), 1343°C (2003) to 1382°C (2001). The longest duration of this interval (average 53 days) is in 2004 at each cultivar, when the temperature sum is the lowest (1277°C) and the precipitation sum is the highest 79 mm. The shortest duration (average 47 days) is in 2001 when the temperature sum is the highest (1382°C) and the precipitation sum is the lowest (33 mm). (Fig.3.). The low temperature sum and high amount of rainfall delay this phenological stages and increased the number of days needful for maturation.



	Blatina	Vranec	Kratoshija	Prokupec	Stanushina
2001 (1382 oC)	44	41	42	45	61
2003 (1343 oC)	46	42	43	47	67
2004 (1277 oC)	48	47	46	51	73

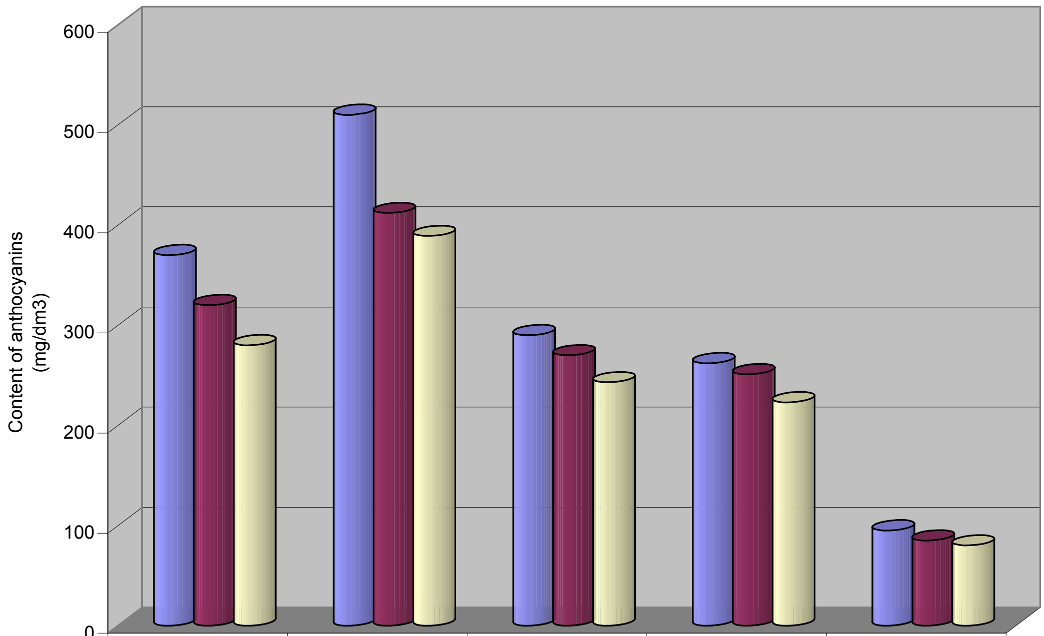
Figure 3 Interval veraison-harvest (days) in correlation with temperatures sum (°C)

One of the more important intervals is the length of the growing season (from estimated budburst to harvest) (tab. 2.)
The growing season from estimated budburst to harvest was found to average 149 days (±10 days SD). The length of the growing season in 2001 was found to 138 days when the temperature sum during vegetation is highest (4328°C)

Year	Temperature sum during vegetation °C	Number of days			
		Budburst-Flowering	Flowering-Veraison	Veraison-Harvest	Budburst-Harvest
2001	4241	39	66	48	**153**
2003	4328	27	62	49	**138**
2004	4010	47	56	53	**156**
Average	4193	38	61	50	**149**
SD	164.34	11	5	3	**10**
CV %	3.94	26.7	8.2	5.3	**6.5**

Table 2 Length of growing season

The content of anthocyanins in the red wines is one the main component responsible for the wine quality. The amount of this parameter mainly depends of the cultivar but also the duration of insolation (number of sunshine hours) has the great influence. The highest amount of anthocyanins is in 2001 when the number of sunshine hours during the interval veraison to harvest is the highest (559 h). The low number of sunshine hours (524 h) decreased the amount of anthocyanins in the wine at each cultivar (fig.4).



	Blatina	Vranec	Kratoshija	Prokupec	Stanushina
2001 (559 h)	370	510	290	262	95
2003 (529 h)	320	412	270	251	85
2004 (524 h)	280	389	243	223	80

Figure 4 Content of anthocyanins (mg/dm^3) in the wine in correlation with insolation sum (h)

Conclusion

The duration of each phenological stage is determinate of cultivar and also of the climate conditions. The temperature sum has a high impact on the duration of each phenological stage. Short duration of phenological stage indicate a good climate condition that facilitate rapid physiological growth.
The length of growing season for Skopje vineyard area from estimated budburst to harvest was found to average 149 days (±10 days SD).
The content of anthocyanins in the wine depends of the cultivar (Vranec-437mg/dm^3, Stanushina-87mg/dm^3), but also the duration of insolation (number of sunshine hours) has the great influence. More sunshine hours increase the content of athocyanins transferred in to the wine.

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