Terroir aspects in development of quality of Egri bikavér

Aspects « terroir » dans le dévelopement de la qualité d'Egri bikavér

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Abstract: Egri Bikavér (Bull's Blood) is one of the most remarkable Hungarian red wines on inland and foreign markets as well. From the end of the 70's the quality of Egri Bikavér was decreasing continually due to mass production. The concept of production of quality wines became general in the mid 90's again and it resulted in a new Origin Control System, for the first time that of Egri Bikavér in Hungary.
In the present study, the effects of different terroirs on wine quality are discussed in the case of Kékfrankos (Blaufränkisch) variety, which is the main component of the blending of Egri Bikavér. The experiments have been carried out in Eger wine region of Hungary. Soil characteristics, mesoclimate and phenological stages were examined at six growing sites. Grapevines in extreme growing sites were described with plant physiological parameters (net photosynthesis, water relations) and canopy structure was also studied. The grapes were harvested at the same time and winemaking technology was the same as well. Beyond the routine chemical analyses, the contents of anthocyanins and polyphenols were also analysed. During the sensory evaluation, the wines were described with radar plots of various parameters.
Remarkable differences were found between the growing sites based on the results of sensory and laboratory analyses. The differences can be explained by the results of soil properties, microclimate and plant physiological measurements. The results of this work may be helpful when the appellation origin control system of Egri Bikavér Superior Eger and Egri Bikavér Grand Superior « terroir » are to be developed.

Key words: soil, microclimate, vine physiology, wine quality, AOC of Egri Bikavér

Introduction

In the recent years the authorities of Eger Wine Region have initiated the development of the origin control system of Egri Bikavér, the most prestigious Hungarian red wine on the domestic and export market. The aim of the present study was to demonstrate the relationship between the wine quality and soil, climatic conditions, vine physiological response in case of Kékfrankos variety grown at different sites of the region. Similar approach has already been applied by several authors about different wine regions worldwide (Barbeau *et al.*, 1998; Van Leeuwen *et al.*, 1998; Tesic, 2001).

Materials and methods

The experiments have been carried out in 2002-2004 in the Eger Wine Region of Hungary (figure 1), located in the North-East part of the country (160-180 meters above sea level). In the present paper, results on *Vitis vinifera* L. cv. Kékfrankos (Blaufränkisch) variety are presented as it is the main component of Egri Bikavér blended wine. The following terroirs and plantations were examined: Eger-Kőlyuktető /1/, Eger-Nagygalagonyás /2/, Eger-Nagyeged Lower /3/, Eger-Nagyeged Upper/4/, Eger-Síkhegy /5/, Egerszólát-Tóbérc /6/ (figure 2).Main soil characteristics were described according to Gál *et al*. (2003). Soil moisture down to 100 cm depth was monitored with a capacitance sensor developed by the Research Institute for Irrigation Szarvas (Hungary). For the comparison of phenological stages at the different growing sites, dates of flowering, veraison and harvest were collected using the descriptions of Riou (1994). For physiological behaviour of the vines differences in water household of the plants (pressure volume curves, according to

Scholander *et al.*, 1965; Turner, 1981) were registered at three dates of the growing season in 2004, in two growing sites differing the most in exposition with Scholander pressure chamber. Photosynthetic characteristics of fully sun-exposed leaves were also measured with a CO_2 gas according to Bálo et *al.* (1999).

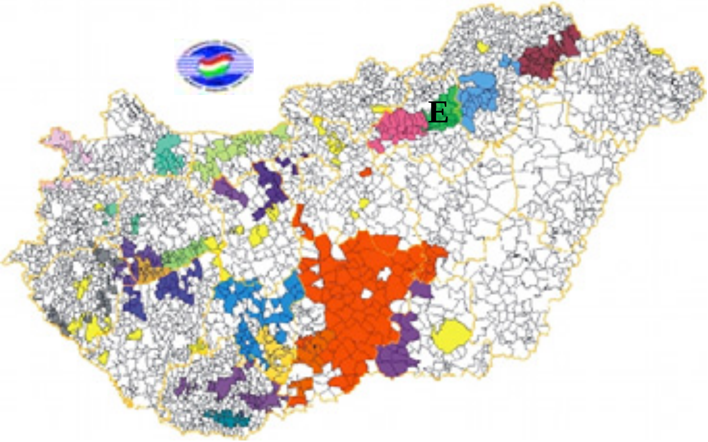

Fig. 1 - Wine Regions of Hungary by FÖMI, VINGIS (E: Eger Wine Region)

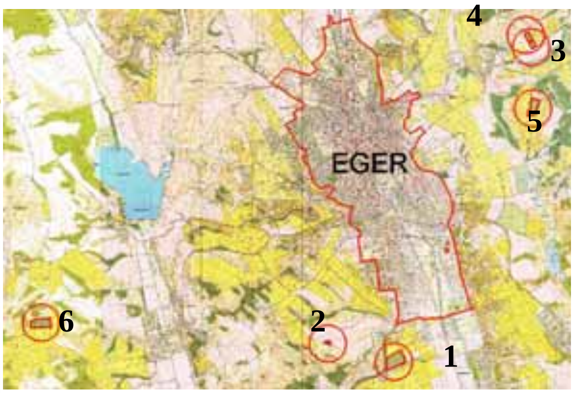

Fig. 2 - Selected sites (1-6) in Eger Wine Region

Canopy exposure (leaf layer number in the fruit zone) was monitored according to Smart and Robinson (1991).
The experimental wines have been produced in micro vinification scales. The volume of the used glass containers was 25 litres and all the experimental parameters (harvest time, maceration method and skin contact time, temperature, application of sulfur dioxide, etc.) were controlled and were the same for all wines. The sensory evaluation of the experimental wines was performed by a 9-member panel, and its results (average values) are compared by the practical radar plots showing the 14 most important sensory elements (figures 7-10). The anthocyanin composition of the experimental wines was measured by HPLC by Giusti *et al.* (1999).

Résultats and discussion

Soil and the vineyard characteristics

Vines were trained on umbrella system, pruning level was 24 buds/vine and the rootstock was BxR T.5C. Vine spacing was 3,0 x 1,0 m for each sites, except for Eger-Kőlyuktető (3,0 m x 1,2 m). The detailed soil characteristics are described in Gál *et al.* (2003).
Eger-Kőlyuktető (site 1.): Brown soil with lessivage with gentle slope formed on ryolit tuff.
Eger-Nagygalagonyás (site 2.): Ramann type brown forest soil, formed on volcanic origin ryolit tuff.
Eger-Nagyeged Lower (site 3.): Ramann type brown forest soil, formed on marine limestone (fig. 3).
Eger-Nagyeged Upper (site 4.): Its gravel-rich brown soil was formed on marine limestone (fig. 3.).
Eger-Síkhegy (site 5): Ramann type (deep) brown soil, formed on volcanic origin ryolit tuff.
Egerszólát – Tóbérc (site 6): Slightly compact brown forest soil formed on volcanic origin ryolit tuff.

Fig. 3 - Ortho photo and picture of the best growing sites: Eger-Nagyeged Lower/3/ and Eger-Nagyeged Upper /4/ sites

Differences in climatic data and phenological stages between terroirs

According to the data collected with meteorological weather stations during this three-year study there was only a slight difference between growing sites in sunshine hours and rainfall (data not published here). Comparing the annual average air temperature in 2004 (measured at 2 m above ground level) the sites Eger-Nagyeged Upper [11,1 °C] and Eger-Síkhegy [11, °C] proved to be slightly warmer, than the others (the lowest being Egerszólát-Tóbérc [10,2 °C] and Eger-Kőlyuktető [10,2 °C]). Interestingly enough, analysing the daily changes of air and soil surface temperature, remarkable differences were found between the sites during the night and the morning hours (figures 4 and 5.). This difference could be observed consequently during the growing

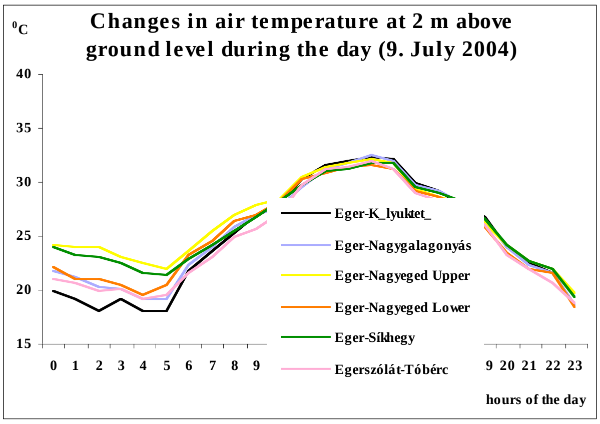

Fig. 4 - Changes in air temperature during the day hours

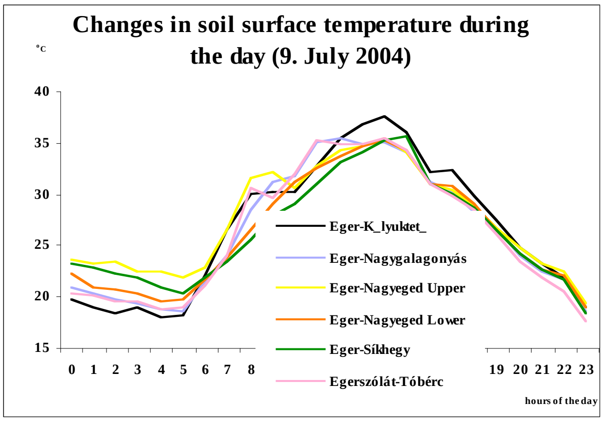

Fig. 5 - Changes in soil surface temperature during the day hours

season. The highest night and early morning temperatures measured at 2 m above ground level and at soil surface were observed in the case of Eger-Nagyeged Upper and Eger-Síkhegy sites followed by Eger-Nagyeged Lower. The lowest value was observed at Eger-Kőlyuktető site. Kliewer and Torres (1972) report that higher night temperature reduces berry anthocyanin concentration however, Roubelakis-Angelakis and Kliewer (1986) and Spayd *et al.* (2002) emphasis that excessively high temperature were detrimental to anthocyanin accumulation but some degree of heat was needed for synthesis. In cool climate viticultural areas, as the present wine region, elevated night temperature may help ripening processes of the berries as it is reflected in total anthocyanin and total polyphenols content of the wines. Figure 6 demonstrates the alterations in soil moisture content of the different sites up to the soil depth of 100 cm. Eger-Nagyeged Upper reflects the lowest value ensuring reduced shoot growth and thus enhancing fruit maturation (Seguin, 1986); that of Eger-Nagyeged Lower is somewhat higher and the soil moisture content of other sites are similarly high.

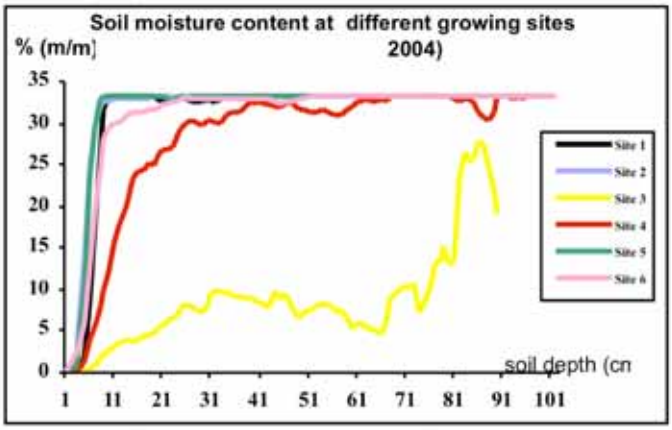

Fig. 6 - Soil moisture content of different sites.

Vine physiological parameters of two extreme growing sites

In respect of physiological responses of Kékfrankos variety two terroirs (Eger-Nagyeged Upper and Eger-Kőlyuktető) were investigated in detail. Generally physiological differences between the experimental sites were significant in each year, although vintage characteristics had considerable effects on stress induced responses. In spite of the fact that there was a very rainy growing season in 2004 differences in physiological responses between the experimental sites were clear, although they were two- or threefold higher in drought stressed vintages (2002 and 2003).

Analysis of pressure volume curves and gas exchange data revealed that terroir specific characteristic (especially different water supply) determined water relations and production of Kékfrankos variety. One of the main criteria of vegetative growth is to sustain the cell turgor. Turgor loss point (TLP) of leaf cells, expressed in RWC (relative water content) loss at incipient plasmolysis, indicates the sensitivity of plant growth to water deficit. Turgor maintenance (delaying turgor loss) was managed by cell wall regulation in both terroirs, although bulk modulus of elasticity (ε), which indicates cell wall rigidity, was higher on the stressed terroir, especially in 2002 and 2003 (the differences were 3-4 MPa, data not shown). More negative π_0 and π_{100} values in Eger-Kőlyuktető are probably due to the higher assimilation rates (P_n) which are influenced by stomatal behaviour and the actual quantum yield (data not shown) Decreased physiological activity on Eger-Nagyeged Upper resulted in reduced vegetative growth also, in fact less leaf layer number (LLN) and thinner canopy was detected in stressed terroir (table 1).

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Eger-Kőlyuktető					
TLP (RWC)	**ε (MPa)**	**π_{100} (MPa)**	**π_0 (MPa)**	**P_n (μmol $m^{-2}s^{-1}$)**	**LLN**
13,17±1,12	9,05±0,3	-1,48±0,06	-1,71±0,23	12,61±1,54	4,8±0,1
Eger-Nagyeged Upper					
TLP (RWC)	**ε (MPa)**	**π_{100} (MPa)**	**π_0 (MPa)**	**P_n (μmol $m^{-2}s^{-1}$)**	**LLN**
11,83±0,29	9,38±1,2	-1,26±0,17	-1,46±0,16	10,43±1,05	4,4±0,4

Table 1 - Characteristic values of the main physiological parameters of Kékfrankos variety in respect of Eger-Kőlyuktető and Eger-Nagyeged Upper

Evaluation of the terroirs' wines

The grapes were harvested at the same time and the winemaking technology was the same as well. The wines were compared by the practical radar plots showing the 14 most important sensory elements as follows: 1- intensity of colour; 2- tone of colour; 3- intensity of odour; 4- fruitiness in odour; 5- tannins in odour; 6- intensity of flavour; 7- fineness of acids; 8- fineness of tannins; 9- fullness of flavour; 10- complexity of flavour; 11- fruitiness in flavours; 12- length of taste; 13- ripeness; 14- balance and harmony. Figures 7 to 12 summarize the sensory parameters of six growing sites and three vintages (2002, 2003 and 2004). In spite of the different weather characteristics of the vintages the two Eger-Nagyeged growing sites (Upper and Lower) show the best and the most uniform quality. The Eger-Kőlyuktető site appears to be the less favourable growing site, at the same time the other three sites (Eger-Nagygalagonyás, Eger-Síkhegy, Egerszólát-Tóbérc) show as large inter-vintage fluctuation as the differences between the two ends of the quality scale covered by the studied wines.

Routine laboratory parameters of Kékfrankos wines have also been determined. Table 2 shows the results for the 2004 vintage. For clarity some cells are marked with colours relating to relatively low (blue) and remarkably high (red) values. The unacceptable parameters and the terroirs are as follows: alcohol content – Eger-Kőlyuktető and Eger-Nagygalagonyás; sugar-free extract – Eger-Kőlyuktető and Eger-Síkhegy; colour intensity – Eger-Kőlyuktető, Eger-Nagygalagonyás and Eger-Síkhegy. The routine analytical parameters of wines of Eger-Nagyeged Lower and Eger-Nagyeged Upper have been found to be superior to that of other terroirs studied. The total anthocyanin contents were acceptable only in case of these two terroirs. The measured total polyphenol indices were above the limits established in most cases, except for Eger-Kőlyuktető and Eger-Nagygalagonyás. These data demonstrate that full-bodied wines of high alcohol content having fine tannins may be produced also in a relatively poor vintage.

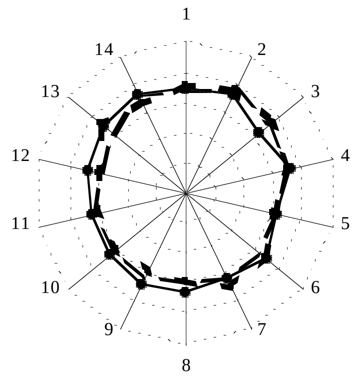

Fig. 7 - Eger-Kőlyuktető

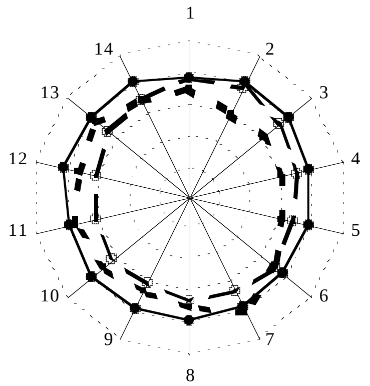

Fig. 8 - Eger-Nagygalagonyás

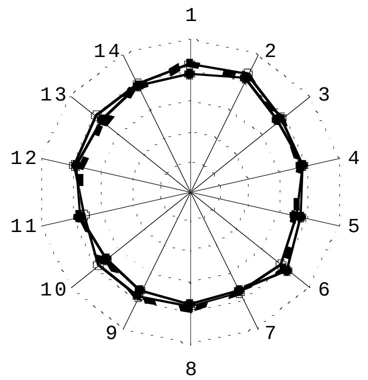

Fig. 9 - Eger-Nagyeged-Upper

Fig. 7-9 - Sensory evaluation (radar plots) of Kékfrankos wines in different years (2002, 2003, 2004)

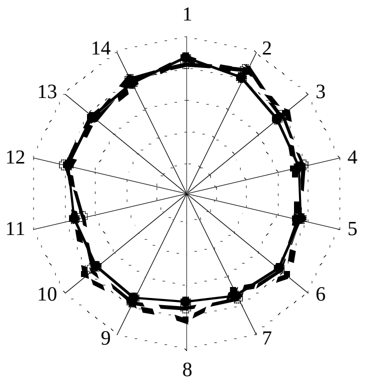

Fig. 10 - Eger-Nagyeged-lower

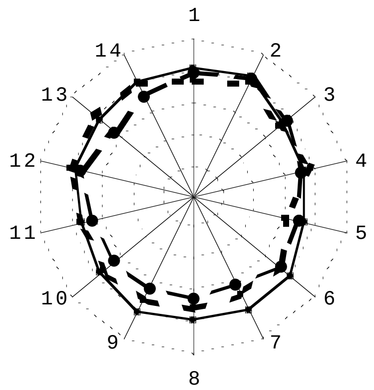

Fig. 11 - Eger-Síkhegy

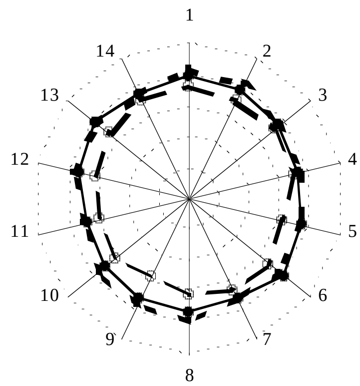

Fig. 12 - Egerszólát-Tóbérc

Fig. 10-12 - Sensory evaluation (radar plots) of Kékfrankos wines in different years (2002, 2003, 2004)

Terroir	Alcohol content (% v/v)	Sugar-free extract (g/l)	Intensity of colour[1]	Total anthocyanin (mg/L)[2]	Total polyphenol index[3]
Eger-Kőlyuktető	10.82	21.74	2.69	138.4	30.4
Eger-Nagygalagonyás	11.46	23.00	2.31	169.3	31.9
Eger-Nagyeged Upper	14.35	36.58	5.24	213.4	54.3
Eger-Nagyeged Lower	14.85	29.10	7.70	274.5	62.1
Eger-Síkhegy	12.73	22.48	3.79	177.2	39.1
Egerszólát-Tóbérc	12.94	23.28	6.25	146.3	46.1

Table 2 - Routine laboratory parameters of Kékfrankos wines

Notes: ■ : values below the limits established for Egri Bikavér
■ : values above the limits established for Egri Bikavér, non-coloured cells – normal values
1 : the intensity of colour is given by the sum of absorbancies using a 1 cm optical path and radiations of wavelengths 420 and 520 nm. (Hungarian standard: MSZ 14848:1979)
2 : mg/L malvidin glycoside
3 : based on the method by Ribéreau-Gayon (1970)

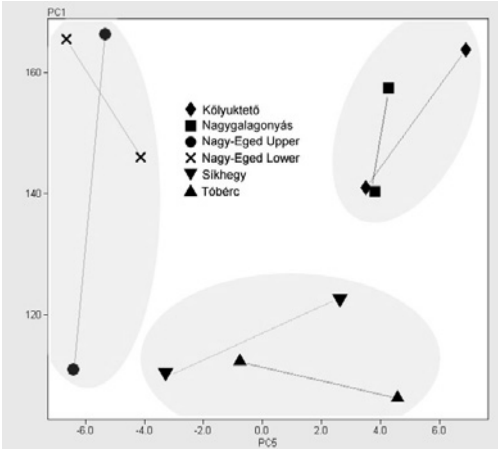

Fig. 12 - Principal component analysis (PCA) of the anthocyanin composition of Kékfrankos wines measured by HPLC

Beside the above routine techniques chromatographic analyses of wines have also been performed. The application of GC and HPLC techniques (gas and liquid chromatography) may reveal the chemical heterogeneity of certain compounds, such as organic acids, volatile aromas, polyphenols, etc. Concerning the anthocyanin composition of the experimental wines in our approach the relative abundance of 13 individual anthocyanin components has been determined and the data were processed by principal component analysis (PCA). Figure 12 shows the PCA plot obtained from the anthocyanin composition of the experimental wines (vintages 2002 and 2003). The PCA plot shows three fairly well separated groups of wines, which is in a good agreement with the results of routine laboratory analyses (although those are obtained from the samples of 2004) and also with the results of sensory evaluation (similarity of Eger-Nagyeged Upper and Lower). The number of the samples studied this way was relatively low, thus the validity of this approach requires further measurements.

Conclusions

The results of the present study showed remarkable differences between experimental sites (« terroirs ») in soil physical characteristics, soil moisture content, mesoclimatic parameters, but only slight alterations in phenological stages.

Extreme terroirs with different ecological conditions were distinguished by stress induced physiological changes. Kékfrankos variety did not show active osmotic adjustment, water relations on tissue level were regulated by cell wall responses.

Eger-Nagyeged Upper and Eger-Nagyeged Lower sites proved to be the best terroirs among the examined ones, resulting in highest wine quality irrespective of vintage. Based on these observations appellation origin control system can be developed distinguishing Egri Bikavér Superior and Egri Bikavér Grand Superior « terroir » (ex. « Nagyeged »).

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