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THE DIFFERENCE IN COLOR AND SENSORY OF ORGANIC QUALITY WINE AND WINE FROM CONVENTIONAL CULTIVATION

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ABSTRACT

This work deals with the colour and sensory evaluation of wines and organic wines from conventional cultivation. 6 organic wines and 6 wines from conventional cultivation were evaluated. The methodology describes colour measurements using spectrophotometry and sensory 20-point-scale system of scoring. The colour evaluation of different varieties did not clearly demonstrate impact of growing on lightness or hue and saturation of wine. Conclusive differences in colour ($P < 0.05$) were established, especially for *Pinot Blanc* and *Malverina* from white varieties and *Medina* from red grapes. The greatest colour stability was demonstrated by *Moravian Muscat*. Sensory evaluation did not show any noticeable differences between the wines of conventional and organic production, there were, however, differences among varieties.

Keywords: wine, organic, conventional, color, sensory evaluation

INTRODUCTION

The foundations of the system of organic farming were laid by the LIBERA Association and PRO-BIO Association in cooperation with the Ministry of Agriculture in 1990. The major contribution to the development of organic agriculture was made by the Ministry of Agriculture. In 1991, five associations of organic farmers were established. After 2001, the legislative, control and certification conditions were set and operational and promotion and consumer awareness were supported **(Liebl, 2010)**.

New rules for organic viticulture introduce technical definition of organic wine which complies with the environmental objectives and principles of the Regulation (EC) No 834/2007 on organic production. The regulation stipulates oenological practices and substances for organic wine. These include the maximum permissible level of sulfite in wine, whose value is determined for red wines to 100 mg/l (150 mg/l for conventional wine) and for white and rosé wines at 150 mg/l (200 mg/l for conventional wine) with a tolerance of 30 mg/l if residual sugar content is higher than 2 g/l **(Vilela *et al.*, 2010)**.

The total acreage of organically farmed area increased to 482,984 hectares, i.e 12% of total agricultural land of the Czech Republic. In terms of share of the organic farming area, the Czech Republic belongs among the leading countries in the world. In the organic viticulture, not only the rules for growing, but also for control are stricter. The cultivation requires resistant varieties of smaller shapes with a small load **(Kraus *et al.*, 1999)**. When attacked by disease (vine downy mildew, powdery mildew of grape), protective equipment, such as plant extracts, minerals, sulfur powder, agents with slight content of copper shall be applied **(Doerr *et al.*, 2000)**.

The grapes must come from vineyards where artificial fertilizers, fungicides, pesticides or herbicides had not been used for at least three years. Planting cover crops and weeds sometimes improves the soil. Also compost, manure and natural enemies of pests and insects are used **(Simon, 2002)**. The goal is to maintain healthy and biologically active soils using natural fertilizers, such as manure. One of the increasingly more common theories concerning ecological vineyards is that they have greater resistance to weather or pests, leading to better performance in poor years with regard to traditional vineyards **(Mulero, Pardo, Zafrilla, 2009)**.

MATERIAL AND METHODS

Plant material

Moravian Muscat which is the most widespread of all the new cultivars in the Czech Republic.

Pinot Blanc is an early white wine grape variety from France. *Malverina* was bred in the Vinselekt Perná. Currently, it is not significantly widespread in the Czech Republic. *Hibernal* – white wine grape variety bred in Germany. In the Czech Republic it is grown on an area of 13 ha. *Blue Portugal* now accounts for the 3.7% of the varietal mix in the Czech Republic. *Medina* is a Hungarian variety grown in the CR on area of 11.5 ha **(Jandurová *et al.*, 2007)**.

Table 1 Labeling of samples

E1	Moravian Muscat from organic production
K1	Moravian Muscat from conventional production
E2	Pinot Blanc from organic production
K2	Pinot Blanc from conventional production
E3	Malverina from organic production
K3	Malverina of conventional production
E4	Hibernal from organic production
K4	Hibernal of conventional production
E5	Blue Portugal from organic production
K5	Blue Portugal from conventional production
E6	Medina from organic production
K6	Medina from conventional production

All samples were provided from the winery Sádek (Kojetice in Moravia), which is located in the village Kojetice Moravia (former district Třebíč, altitude 420-480 m). Vineyards are located below the castle Sadek protected on three sides by forest. It provides very good conditions for cultivation of vine.

Measurement of colour

Colour measurements were performed in the physical laboratory of the Institute of Food Technology at MENDELU. There were two wine samples from each group; the measurements were repeated. To determine the values and differences in color spectrophotometer Konica Minolta CM-3500d was used – viewing angle

10°, D65. This device enables the measurement of spectra (transmittance) of liquids in 1 cm cuvettes and evaluation is carried out using software program CMs-100W SpectraMagic NX in the CIELAB system (CIE 1976). The values of L* (wine lightness) take values from 0 to 100 (black-white), values a*, b*, C*, h^0 are represented by colour coordinates in the system which may be in 3D space CIE presented by L* a* b* or L* C* h^0. It is useful to place them parallel to each other especially when comparing samples. Coordinate a* represents the distance at the axis in the direction of green (-a*) – red (a*) and b* coordinate in the direction of blue (-b*) – yellow (b*). C* stands for chroma and h^0 for hue. As comparative control sample distilled water was used fro the measuring. Based on the values of L* a* b* *total colour difference* can be described indicating the colour difference within the system from the control sample or model **(Huertas et al., 2003)**. This value of ΔE^*_{ab} (Fig. 1) is not only an indication of how big the differences between samples are, but it is also showing the extent (control) to which the observer is able to distinguish the difference. The hardware error when measuring the $\Delta E^*_{ab} = 0.04$, sensitivity of the observer using sensory evaluation differs in individual studies **(Sharma *et al.*, 2005)** from $\Delta E^*_{ab} = 1$ to 3. Therefore, despite determination of conclusive differences in colorimetric measurements there may not necessarily be a noticeable difference in the evaluation of lightness and colour by the evaluator. For our purposes, we chose the value of $\Delta E^*_{ab} = 2.0$ as a just noticeable difference, because wine is a liquid, the colour of which is due to the long tradition and experience of evaluators easily evaluated.

$$\Delta E^* = \sqrt{\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2}}$$

Fig. 1: Calculation of the total colour difference **(Cie 2004; Pridmore *et al.*, 2004)**

Sensory evaluation

The sensory evaluation was carried out by ten trained evaluators. For the evaluation 20-point-scale system of scoring was used, which is, according to **Gamasa *et al.*, (2009)** the best method of evaluation. The colour, clarity, smell and taste were evaluated.

Of all measured values the basic statistical values using the UNISTAT 5.1. programme were established. By analysis of variance (ANOVA) with multiple comparison using Tukey's test conclusive differences ($P < 0{,}05$) were detected.

RESULTS AND DISCUSSION

Colour

When measuring the colour of wine the differences between varieties of Moravian Muscat, Pinot Blanc, Malverina, Hibernal, Medine and Blue Portugal (1 to 6) depending on the cultivation mode (K=conventional, E=organic) and the date of measurement (0, 150, 220 days) were monitored.

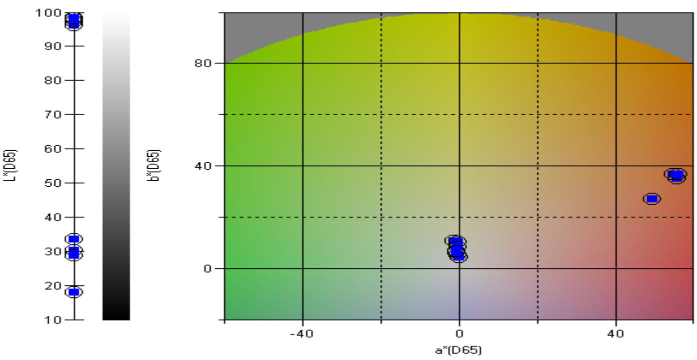

Figure 1 Varietal wines in the CIELAB system

The basic characteristics of the colour for the entire experiment in the CIELAB system (Fig. 1) are listed in Tab. 1. These values show obvious differences between white and red wines ($P < 0.05$); among white wines however there were no differences detected ($P > 0.05$), conclusive difference between Medina and Blue Portugal was found ($P < 0.05$), except for hue h^0, they were detected in the remaining coordinates (L*, a*, b*, C*). Wine with the highest lightness was the variety of Malverina, the darkest was Blue Portugal.

Table 1 The basic characteristics of the CIELAB colour among the examined varieties ($\bar{x}$ ±SD, n=12)

Variety	L*	a*	b*	C*	h^0
Moravian Muscat	98.23 ± 0.22^a	-0.57 ± 0.11^a	6.52 ± 0.27^a	6.55 ± 0.27^a	95.05 ± 1.09^a
Pinot blanc	98.02 ± 1.02^a	-0.30 ± 0.32^a	6.28 ± 1.81^a	6.29 ± 1.81^a	92.94 ± 3.23^a
Malverina	98.27 ± 0.52^a	-0.57 ± 0.47^a	6.29 ± 2.32^a	6.32 ± 2.33^a	94.94 ± 3.56^a
Hibernal	97.75 ± 0.51^a	-0.41 ± 0.15^a	7.45 ± 1.30^a	7.46 ± 1.30^a	93.17 ± 1.29^a
Medine	24.67 ± 7.85^b	52.53 ± 4.64^b	30.74 ± 4.33^b	60.97 ± 5.18^b	30.31 ± 3.33^b
Blue Portugal	18.53 ± 8.40^c	48.27 ± 6.39^c	26.71 ± 8.51^c	55.34 ± 9.63^c	28.14 ± 4.90^b

$^{a, b, c}$– indexes indicate conclusive differences among the groups in the columns at the surface ($P<0.05$)

What is far more important are of course the demanded results between the modes of cultivation. Various authors studying differences between organic and conventional modes reached different results, yet some conclusions point to a greater importance of other factors (species, location, etc.).

Organic wines show lower lightness (L*) than wines from the conventional regime; in all varieties, except Hibernal, the differences were conclusive ($P < 0.05$). For white wines, in terms of the time of storage, the change of lightness over time (ΔL^*) was not as apparent as for red wines; this was mostly the case of the Medine varieties (conventional 17.53; organic 12.35). The values of a* and b* can be, to some extent, substituted by chroma (C*) and hue h^0 which are easier to understand. Nevertheless, most authors use L*a*b*. The value b* is, however, linked to C* (chroma). For cross-varietal evaluation there should be more specific the value of h^0 (hue). Chroma C* for groups with different modes (C/O) and storage time (0/150/220) did not follow the same trend for different varieties. For Medine it significantly decreased, and it was higher at the organic mode. The most stable C* had Moravian Muscat.

For Moravian Muscat hue h^0 was constantly changing and with the exception of the second measurement (150 days), it was moving from the green towards yellow (yellow 60, green 120). Here was also, perhaps the most obvious, conclusive ($P < 0.05$) effect of storage. The course of hue changes of Pinot Blanc and Malverina was broadly similar. In the case of red wines the hue went from light red to cooler colour tones.

Table 2 Basic characteristics of the CIELAB colour depending on the mode and date of measurement ($\bar{x}$ ±SD, n=4)

Date of measurement	0 days		150 days		220 days	
Mode of cultivation	Conventional	Organic	Conventional	Organic	Conventional	Organic
L*						
- Moravian Muscat	98.63 ± 0.01^a	98.37 ± 0.01^b	97.98 ± 0.01^c	98.21 ± 0.04^d	98.11 ± 0.01^e	98.08 ± 0.01^e
- Pinot Blanc	98.72 ± 0.01^a	98.01 ± 0.01^b	98.26 ± 0.02^c	95.87 ± 0.19^d	98.72 ± 0.02^a	98.52 ± 0.01^e
- Malverina	98.89 ± 0.01^a	98.87 ± 0.01^a	97.47 ± 0.04^b	98.28 ± 0.08^c	97.85 ± 0.01^d	98.28 ± 0.01^c
- Hibernal	97.73 ± 0.01^a	98.55 ± 0.02^b	97.98 ± 0.03^c	96.87 ± 0.06^d	97.63 ± 0.01^e	97.71 ± 0.01^a
- Medine	34.11 ± 0.29^a	29.30 ± 0.05^b	33.17 ± 0.42^c	17.90 ± 0.14^d	16.58 ± 0.01^e	16.95 ± 0.01^e
- Blue Portugal	16.89 ± 0.09^a	15.45 ± 0.01^b	28.68 ± 0.02^c	30.22 ± 0.01^d	11.78 ± 0.01^e	8.14 ± 0.01^f
a*						
- Moravian Muscat	-0.71 ± 0.02^a	-0.61 ± 0.01^b	-0.65 ± 0.01^c	-0.60 ± 0.01^b	-0.49 ± 0.01^d	-0.39 ± 0.01^e
- Pinot Blanc	-0.86 ± 0.01^a	0.17 ± 0.02^b	-0.30 ± 0.01^c	-0.31 ± 0.02^c	-0.42 ± 0.01^d	-0.10 ± 0.01^e
- Malverina	-0.64 ± 0.03^a	-0.67 ± 0.02^a	-1.43 ± 0.01^b	0.06 ± 0.01^c	-0.46 ± 0.02^d	-0.27 ± 0.02^e
- Hibernal	-0.42 ± 0.01^a	-0.23 ± 0.01^b	-0.69 ± 0.02^c	-0.39 ± 0.02^d	-0.42 ± 0.01^a	-0.29 ± 0.01^e
- Medine	52.77 ± 0.08^a	60.72 ± 0.05^b	55.81 ± 0.07^c	49.11 ± 0.14^d	48.21 ± 0.01^e	48.59 ± 0.02^f
- Blue Portugal	49.88 ± 0.09^a	48.34 ± 0.01^b	55.95 ± 0.02^c	54.53 ± 0.01^d	42.89 ± 0.01^e	38.02 ± 0.01^f

b*						
- Moravian Muscat	6.06 ± 0.02^{a}	6.54 ± 0.01^{b}	6.79 ± 0.01^{c}	6.28 ± 0.01^{d}	6.72 ± 0.02^{e}	6.74 ± 0.01^{e}
- Pinot Blanc	5.75 ± 0.02^{a}	6.08 ± 0.01^{b}	5.39 ± 0.02^{c}	10.17 ± 0.07^{d}	5.07 ± 0.01^{e}	5.21 ± 0.02^{f}
- Malverina	4.39 ± 0.03^{a}	4.42 ± 0.03^{a}	10.51 ± 0.01^{b}	4.41 ± 0.02^{a}	7.82 ± 0.02^{c}	6.18 ± 0.01^{d}
- Hibernal	8.21 ± 0.01^{a}	4.98 ± 0.02^{b}	6.66 ± 0.02^{c}	8.42 ± 0.12^{d}	8.66 ± 0.02^{e}	7.75 ± 0.02^{f}
- Medine	38.01 ± 0.13^{a}	28.43 ± 0.04^{b}	35.10 ± 0.27^{c}	26.71 ± 0.21^{d}	27.85 ± 0.08^{e}	28.37 ± 0.05^{b}
- Blue Portugal	27.45 ± 0.10^{a}	25.41 ± 0.07^{b}	36.77 ± 0.04^{c}	36.80 ± 0.07^{c}	20.01 ± 0.06^{d}	13.83 ± 0.01^{e}
C*						
- Moravian Muscat	6.10 ± 0.01^{a}	6.57 ± 0.01^{b}	6.82 ± 0.01^{c}	6.31 ± 0.01^{d}	6.74 ± 0.01^{e}	6.75 ± 0.01^{e}
- Pinot Blanc	5.81 ± 0.01^{a}	6.08 ± 0.01^{b}	5.40 ± 0.01^{c}	10.18 ± 0.08^{d}	5.09 ± 0.01^{e}	5.21 ± 0.02^{f}
- Malverina	4.43 ± 0.02^{a}	4.47 ± 0.02^{b}	10.61 ± 0.01^{c}	4.41 ± 0.01^{a}	7.83 ± 0.02^{d}	6.19 ± 0.02^{e}
- Hibernal	8.22 ± 0.01^{a}	4.99 ± 0.02^{b}	6.70 ± 0.01^{c}	8.43 ± 0.12^{d}	8.67 ± 0.02^{e}	7.76 ± 0.02^{f}
- Medine	65.04 ± 0.14^{a}	67.04 ± 0.03^{b}	65.93 ± 0.21^{c}	55.90 ± 0.23^{d}	55.67 ± 0.03^{d}	56.26 ± 0.02^{e}
- Blue Portugal	56.93 ± 0.12^{a}	54.61 ± 0.03^{b}	66.95 ± 0.01^{c}	65.78 ± 0.03^{d}	47.32 ± 0.01^{e}	40.45 ± 0.01^{f}
h^{0}						
- Moravian Muscat	96.63 ± 0.19^{a}	95.34 ± 0.04^{b}	95.44 ± 0.03^{b}	95.43 ± 0.09^{b}	94.17 ± 0.15^{c}	93.28 ± 0.09^{d}
- Pinot Blanc	98.53 ± 0.10^{a}	88.40 ± 0.15^{b}	93.15 ± 0.13^{c}	91.72 ± 0.12^{d}	94.74 ± 0.09^{e}	91.09 ± 0.07^{f}
- Malverina	98.31 ± 0.38^{a}	98.52 ± 0.25^{a}	97.74 ± 0.06^{b}	89.26 ± 0.19^{c}	93.34 ± 0.09^{d}	92.49 ± 0.20^{e}
- Hibernal	92.91 ± 0.08^{ac}	92.60 ± 0.13^{b}	95.93 ± 0.16^{d}	92.65 ± 0.11^{b}	92.77 ± 0.04^{c}	92.14 ± 0.07^{e}
- Medine	35.77 ± 0.06^{a}	25.09 ± 0.05^{b}	32.17 ± 0.17^{c}	28.54 ± 0.13^{d}	30.01 ± 0.07^{e}	30.28 ± 0.05^{f}
- Blue Portugal	28.83 ± 0.05^{a}	27.73 ± 0.06^{b}	33.31 ± 0.04^{c}	34.02 ± 0.06^{d}	25.01 ± 0.07^{e}	19.98 ± 0.01^{f}

^{a,b,c,d,e,f} – indexes indicate conclusive differences among the groups in the rows at the surface (P<0.05)

Conclusive differences (P<0.05) from the colour measurements (see Tab. 2) point to the impact of the wine storage on colorimetric values. However, they should not be – also due to the small number of samples – overstated. It is necessary to point out the considerable sensitivity of the method and device compared to human observation (evaluation). Therefore, it is necessary to provide values of change ΔE^*_{ab} for determining the observable difference by the human eye ($DE^*_{ab} > 2.0$).

In this case, in the Tab 3 with factors we could observe significant differences between varieties. The greatest difference was seen in the varieties of red wines Medine and Blue Portugal, where all the factors showed observable difference. For white wines, the colour differed depending on the mode of cultivation with Pinot Blanc and Malverina, marginally also with Hibernal, in the case of difference in colour in the organic mode. Storage did not show any noticeable impact with any classification except for Moravian Muscat. Dynamics of changes differs with wines: the most stable of all the wines is thus Moravian Muscat, the least stable among white wines is Malverina and among red wines Medine.

Table 3 The total colour change (DE^*_{ab}) of studied varieties depending on various factors

The total colour change	ΔE^*_{ab}	ΔE^*_{ab}		ΔE^*_{ab}		ΔE^*_{ab}	
(DE^*_{ab})	K/E	0/150	0/220	K0/150	K0/220	E0/150	E0/220
Moravian Muscat	0.09	0.47	0.63	0.98	0.87	0.30	0.42
Pinot blanc	2.12*	2.28*	0.82	0.81	0.81	4.63*	1.05
Malverina	2.66*	3.22*	2.74*	6.34*	3.59*	0.93	1.90
Hibernal	0.82	1.20	1.68	1.59	0.46	3.83*	2.89*
Medine	8.80*	7.86*	17.86*	4.31*	20.77*	16.36*	17.31*
Blue Portugal	3.96*	17.92*	14.28*	16.21*	11.42*	19.66*	17.14*

* - index indicates difference just noticeable by human eye among the compared groups of results

For example **Zafrilla *et al.*, (2003)**; **Recamales *et al.*,. (2003)** examined the content of phenolic compounds and antioxidant capacity of red and white wines in different modes. In the case of red wines, greater antioxidant capacity was demonstrated than with white wines, but the effect of mode was not confirmed – the white wines in the organic mode showed higher values even during storage (8 months).

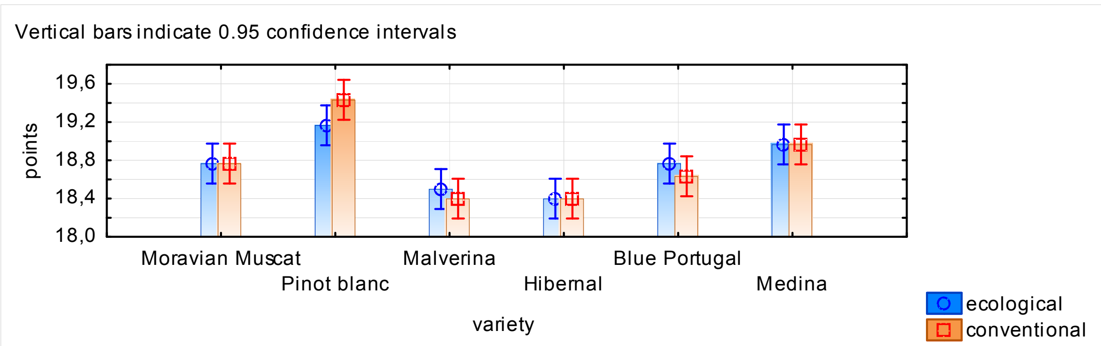

Figure 2 Effect of cultivation and variety on the overall sensory evaluation in points

Sensorics

From Figure 2 it is evident that the top sensory rating received the variety Pinot Blanc – the conventional mode of cultivation got higher rating and statistically different evaluation (P <0.05), compared to organic wine. Lagering makes the colour of the wines heavier and the body becomes fuller **(Kraus, 2005)**. The varieties of Malverina and Blue Portugal grown organically were evaluated as better than the conventional ones, but the comparison was not statistically significant. The evaluation for Moravian Muscat, Hibernal and Medina was the same in both production methods.

The lowest sensory evaluation was with the variety Medina, reaching 17.6 points for both cultivation modes. Red wines had less points compared to white wines. The overall taste perceived in food consumption is caused by simultaneous stimulation of several senses. It is proven that scents can suppress, enhance or even to have no effect on the taste **(Sáenz-Navajas *et al.*, 2010)**.

CONCLUSION

The colour evaluation of different varieties did not clearly demonstrate impact of growing on lightness or hue and saturation of wine. Conclusive differences in colour (P <0.05) were established, especially for Pinot Blanc and Malverina from white varieties and Medina from red grapes. The greatest colour stability was demonstrated by Moravian Muscat.

The top sensory rating was received by the variety Pinot Blanc – the conventional mode of cultivation got higher rating and statistically different evaluation (P <0.05), compared to organic wine. Red wine had lower rating compared to white wines. Among the wines of conventional and organic production no conclusive differences were found among the varieties, except for Pinot Blanc. In summary it can be stated that the impact of the mode of cultivation and storage of the selected varietal wines depends on certain conditions. And despite some conclusive differences these were not as significant as the differences between the varieties themselves. Nevertheless, this findings may provide valuable knowledge and a control mechanism that could help us avoid undesirable factors in the technology of wine production.

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