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Ireneusz OCHMIAN, Kamila MIJOWSKA

COMPARISON OF THE QUALITY OF FRUITS FROM TWO VINE CULTIVARS AND THE INFLUENCE OF THE MACERATION PROCESS ON WINE QUALITY

PORÓWNANIE JAKOŚCI OWOCÓW DWÓCH ODMIAN WINOROŚLI I WPŁYW PROCESU MACERACJI NA JAKOŚĆ WIN

Department of Horticulture, West Pomeranian University of Technology, Szczecin, Poland

Streszczenie. W Polsce w ostatnich latach obserwuje się wzrost zainteresowania uprawą i przetwórstwem winorośli. Charakter i jakość wina kształtuje wiele czynników, które określa francuski termin *terroir*. Obiektem prowadzonych badań były owoce winorośli odmian 'Monarch' i 'Regent'. Oceniano wielkość i jakość jagód oraz wpływ temperatury i czasu maceracji owoców na kwasowość, pH i barwę wina. Owoce badanych odmian nie różniły się wielkością jagód. Większą zawartością ekstraktu charakteryzowały się owoce odmiany 'Regent', a większą zawartością kwasów oraz niższym pH świeżego moszczu i wina cechowała się odmiana 'Monarch'. Najwyższą kwasowość odnotowano w przypadku win uzyskanych z owoców odmiany 'Monarch' poddanych ośmiodniowej maceracji. Wzrostowi odczynu wina sprzyjały wyższa temperatura i wydłużenie okresu maceracji. Barwa soku ulegała zmianie także po zakończeniu maceracji miazgi, tj. w czasie dojrzewania młodego wina. Sok gronowy i wino sukcesywnie ciemniały, jednocześnie następowała ekstrakcja związków nadających mu barwę niebieską, zwłaszcza w wyższej temperaturze.

Keywords: colour, extract, maceration time, maceration temperature, *Vitis.*
Słowa kluczowe: barwa, czas maceracji, ekstrakt, temperatura maceracji, *Vitis.*

INTRODUCTION

The character and quality of Polish wine is shaped by a large number of factors defined by the French term '*terroir*'. This notion refers to, amongst other things, to the climate, topography, soil, cultivation technology and fruit processing (Casamayor 2008). The quality features pertaining to the extract, acidity, the type of aroma, the ageing ability, etc., largely depend on local conditions (Bosak 2004). Running a vineyard requires the application of various treatments (Arkell 2009). The time of harvesting fruits intended for processing is of significant importance for wine quality, which occurs after the so-called processing maturity. At that time, grape juice is characterised by an appropriate content of sugars and organic acids (Lisek 2011). During the maturation process, the level of sugars, amino acids and soluble proteins and the concentration of organic acids decrease (Holler 2005). In addition, polyphenols are obtained in fruits, including tannins, dyes and some flavouring substances. Red cultivars are characterised by a higher content of phenolic compounds (Priewe 2003), which the colour, flavour and tartness of wine largely depend on (Cadot et al. 2012).

Corresponding autor – Adres do korespondencji: PhD Ireneusz Ochmian, Department of Horticulture West Pomeranian University of Technology, Szczecin, Juliusza Słowackiego 17, 71-434 Szczecin, Poland, e-mail: iochmian@zut.edu.pl

Depending on the type of the wine made, various grape-processing methods are used. Vinification of red wine is primarily based on maceration and fermentation processes, as it is at this time that the extraction of dyes, tannins and aromatic compounds occurs (Collombet and Paireault 1997). Also, in the case of vinification of white wines from aromatic cultivars, such as muscats, the production includes a several-hour pulp maceration process (Bosak 2006). Alcohol fermentation is a process occurring with the participation of yeasts (Cieślak 1991). It is defined as the biotransformation of fruit sugars, including glucose and fructose into ethyl alcohol and carbon dioxide (Pretorius 2000). Temperature is the most important factor influencing the fermentation process – its optimal value for yeast propagation and fermentation is 30ºC (Bosak 2008, Steidl and Renner 2008). However, it does not always have a beneficial effect on the quality of wine, especially of white wine, as it poses a risk of aroma and alcohol oxidation in the product (Bosak 2008). Fermentation at low temperatures of 12–10ºC, and even at 8ºC, is a slow process and it is only possible with the participation of selected yeasts. Wines obtained by means of this method have a clear colour, they are fresh; however, they are rarely distinct and the odour structure undergoes only slight changes during the transformation from the must to the wine stage (Priewe 2003).

The aim of the research was to compare the quality of fruits of two grapevine cultivars and to show changes of the must in the maceration process.

MATERIAL AND METHODS

The object of the study involved grapes from two dark cultivars: ‘Monarch’ and ‘Regent’. The influence of the temperature and the maceration time on the quality of the must and wine was analysed (Table 1).

Table 1. Structure of the experiment – methods of maceration
Tabela 1. Schemat doświadczenia – metody maceracji

	Cold maceration Maceracja zimna (7–10ºC)	Warm maceration Maceracja ciepła (18–20ºC)	Short maceration Maceracja krótka (8 days – 8 dni)	Long maceration Maceracja długa (14 days – 14 dni)
M1*	•		•	
M2	•			•
M3		•	•	
M4		•		•
R1	•		•	
R2	•			•
R3		•	•	
R4		•		•

*Explanations – Objaśnienia: ‘Monarch’ (M 1–4), ‘Regent’ (R 1–4).

'Monarch' – a cultivar of German origin with regular yields and strong growth. Time of harvest are a little later than average, about the same as Pinot noir Fruits are characterised by a relatively low level of sugar, but high-quality wines are obtained from them. Wine have intensive colour in Pinot type, rich in polyphenol and with an interesting fruity character (Winegrowers Supplies…, http://www.winegrowers.info/varieties/Vine_varieties/Monarch.htm).

'Regent' – a German cultivar characterised by moderate growth and high yields. Size fruit is small to medium and red-blue skin colour. Time of harvest is middle-early. Wine is characterised by a rather low tannin content, a mild taste and a fruity bouquet (Myśliwiec 2006) sometimes hints of blackcurrant, full bodied, Bordeaux style, as well as a very dark deep red colour (Bieńczyk and Bońkowski 2008, Winegrowers Supplies…, http://www.winegrowers.info/varieties/Vine_varieties/Regent.htm).

The tests were performed in the Horticulture Department of the West Pomeranian University of Technology in Szczecin. The Research Station is located in the Szczecińska Lowland. In this area, there are numerous hills of 20–60 m ASL, the remnants of the frontal moraine. This affects the distribution of rainfall intensity, number of hours of sunlight, temperature and wind speed. The climate of this area is also significantly affected by the presence of large water basins (Szczecin Lagoon, Dąbie Lake, the Odra River), which provide additional moisture in the period of plant vegetation. The majority of the West Pomeranian Province belong to the zone 7A on the Heinz and Schreiber's "Map of zones of plant resistance to frost". Minimal temperatures range from –15ºC to –17ºC here. However, in the area of Szczecin and in the nearby northern region, minimal temperatures range from –12ºC to –15ºC, which corresponds to values typical of zone 7B. The soil had a medium-level potassium and phosphorus content and it was rich in magnesium, and soil pH was 6.7–7.1. Every spring, nitrogen fertilization was applied at a dose of 60 kg together with watering using a drip-line irrigation system and magnesium sulphate of 50 kg per ha. The doses of water and the dates of their application were established by using a tensiometer. Suction force of the soil was maintained at about 1.5–2.2 pF. Also within the growing period, the bushes were sprayed 4 times with calcium solutions until the full wetting of the leaves. Liquid calcium fertilizers, designed for foliar fertilization of plants and fruit, were used, together with the Silwet®Gold preparation enhancing the adhesion properties. Shrubs grafted on rootstock Kober 125 AA were planted in 2006 at a spacing of 2.3 × 1.2 m in three repetitions in a random subblock system. Plants were carried out in the single Guyot system.

After the hand harvest, the grapes were measured and next weighed; the weight of 100 randomly selected grapes was determined. For this purpose, a scale ruler (in centimetres) and an electronic weighing scale were used (in grams). Next, the chemical composition of the fruits was examined. The total acidity was determined by titration expressed as malic acid (k = 0.067). The extract content was examined refractometrically using a PAL–1 electronic device (Atago Japan). The pH was determined using an Elmetron CX–732 pH-meter. Next, the grapes were destalked and crushed to obtain fruit pulp which was put into a fermentation bin. Potassium pyrosulfite was added to the pulp at a dose of 1 gram per 10 litres of must to destroy wild yeasts. After 24 hours, the sugar level was examined in samples of juice obtained from the cultivars and sugar was added to them to obtain a 23% sugar content. At the next stage, the pulp was inoculated with wine yeast cultures of *Saccharomyces cerevisiae* (PDM+VR5). The bins were placed in a cold store at 7º–10ºC and in a heater

room at 18º–20ºC. During fermentation, the pulp was mixed every 12 hours to remove carbon dioxide. After 8 and then 14 days, using a pleated filter, the must was filtered from the pulp and it was poured into fermentation bottles.

The colour of the must obtained directly after crushing and also during warm and cold maceration as well as the colour of the wine was observed. The colour parameters were determined using a KonicaMinolta CM–700d spectrophotometer in the passing light in glass trays. The measurements were made in the CIE L*a*b* system.

After five months after the completion of the maceration process, the colour, total acidity and the pH were ultimately measured in the wine.

To find out whether there existed significant differences in the quality and chemical composition of fruits of the tested cultivars, one- and two-way analysis of variance was used using the Statistica 10.1 software (Statsoft, Poland). The means were verified using Tukey's test at a significance level of α = 0.05.

RESULTS AND DISCUSSION

The measurement of the weight of vine fruits is a helpful factor during the grape destalking. On the basis of analysis of the results, no significant differences in the weight of 100 fruits were observed (Table 2) between the 'Monarch' and 'Regent' cultivars (210–218 g). Ochmian et al. (2013 b) obtained different results during an experiment investigating the influence of soil cultivation on the weight of Regent cultivar fruits, the weight of 100 grapes ranged from 126 to 144 g.

Table 2. Weight of 100 fruits and the quality parameters of two grape varieties 'Monarch' and 'Regent'
Tabela 2. Masa 100 owoców i parametry jakościowe dwóch odmian winorośli – 'Monarch' i 'Regent'

Fresh must – Świeży moszcz	Cultivar – Odmiana	
	'Monarch' (M)	'Regent' (R)
Weight of 100 fruits Masa 100 owoców (g)	210 a	218 b
Extract Ekstrakt (ºBx)	15.92 a	21.45 b
Titratable acidity Kwasowość (g · 100 ml^{-1})	1.20 b	0.98 a
Juice pH pH soku	2.85 b	3.27 a

*Average verified Tukey test at a significance level α = 0.05.
*Średnie weryfikowane testem Tukeya na poziomie istotności α = 0,05.

A high extract content in fruits is certainly a desirable characteristic and it is very important for the winemaking technology. Experience has shown that 'Regent' cultivar fruits had significantly higher extract content (21.45ºBx) compared to fruit cultivar 'Monarch' – 15.93ºBx (Table 2). A comparably high extract content in fruits was obtained by Krośniak et al. (2009) for white grapes from the Seyval Blanc (22.8%) and Jutrzenka (21.1%) cultivars for the Muskat Odeski cultivar (16.4%). Gil et al. (2012) claim that the process of proper grape maturation influences the growth of sugar concentrations and a decrease in fruit acidity. In the

experiment, significant differences in the acidity of grape juice and young wine of the tested vine cultivars were observed. The organic acids of low molecular weight are an important group of compounds in the grape juice and wine, because they have an impact on certain aspects, such as the organoleptic properties (color, taste and aroma), stability, or microbiological control (Peynaud 1999). Both the 'Monarch' must and wine were characterised by higher acid concentrations of 1.20 and 0.86 g · 100 ml^{-1}, respectively (Tables 2, 3).

Table 3. The quality parameters of wines from two grape varieties 'Monrach' and 'Regent'
Tabela 3. Parametry jakościowe młodego wina z dwóch odmian winorośli – 'Monrach i Regent'

	Cultivar – Odmiana		
Maceration – Maceracja	'Monarch' (M)	'Regent' (R)	Mean – Średnia
	Titratable acidity wine Kwasowość wina (g · 100 ml^{-1})		
Cold 8 days – Zimna – 8 dni	0.92 a	0.87 ab	0.90 a
Cold 14 days – Zimna – 14 dni	0.74 d	0.76 cd	0.75 c
Warm 8 days – Ciepła – 8 dni	0.95 a	0.72 d	0.84 b
Warm 14 days – Ciepła – 14 dni	0.84 bc	0.79 bcd	0.82 b
	0.86 a	0.79 b	
	Wine pH – pH wina		
Cold 8 days – Zimna – 8 dni	3.10 c	3.48 ab	3.29 b
Cold 14 days – Zimna – 14 dni	3.20 bc	3.50 ab	3.35 ab
Warm 8 days – Ciepła – 8 dni	3.20 bc	3.62 a	3.41 ab
Warm 14 days – Ciepła – 14 dni	3.40 abc	3.60 a	3.50 a
	3.23 b	3.55 a	

*Average verified Tukey's test at a significance level α = 0.05.
*Średnie weryfikowane testem Tukeya na poziomie istotności α = 0,05.

For the Regent cultivar, the results were the following: fresh must 0.98 g · 100 ml^{-1}, wine 0.79 g · 100 ml^{-1} (Table 2, 3). It was also observed that, as compared to the fruits, the organic acid content in wine decreased. The highest acidity was observed in samples macerated at lower temperatures (7º–10ºC) and in a shorter time (8 days) – 0.90 g · 100 ml^{-1}, and the lowest also in samples kept under cool conditions and with an extended maceration process of up to 14 days – 0.75 g · 100 ml^{-1} (Table 3). For the 'Regent' cultivar, it was noticed that the extension of the cold maceration period resulted in a decrease in wine acidity and the extension of this process, especially at a higher temperature, had a reverse effect. It shows that the adopted wine vinification method may be of significant importance for shaping the quality parameters. Similar observations were made by Ristic et al. (2011) by obtaining a lower acidity and higher pH in table red wine made from Garnacha fruits, as compared to rosé wine obtained from this cultivar. While analysing the results, it was observed that the pH of the wine was higher than the pH of the fresh must and the 'Regent' cultivar (pH of fresh juice – 3.27, pH of wine – 3.55) was characterised by higher pH, as compared to the 'Monarch' cultivar (pH of juice – 2.86, pH of wine – 3.23) (Table 2, 3). It was also noticed that wine with a higher pH was obtained from fruits macerated at higher temperatures, as compared to samples macerated at lower temperatures. The lowest pH of wine was observed for samples macerated for 8 days at lower temperatures (pH – 3.29), and the highest pH was for samples macerated at higher temperatures for 14 days (pH – 3.50) (Table 3). During research on four white wines from the Puglia region in Italy, Esti et al. (2007) observed a pH ranging from 3.40–3.89.

While examining the influence of temperature and the length of the maceration process on the wine must colour, a significant influence of these factors on the L* and b* parameters was observed. The L* index conditioning the colour intensity decreased gradually, which indicates the darkening of the juice during maceration. The 'Monarch' cultivar was characterised by a lighter colour of the fresh must, as compared to the 'Regent' cultivar. Moreover, the 'Monarch' cultivar was characterised by the greatest changes in the colour intensity and the darkest colour of young wine, L* – 8.49 (Fig. 1).

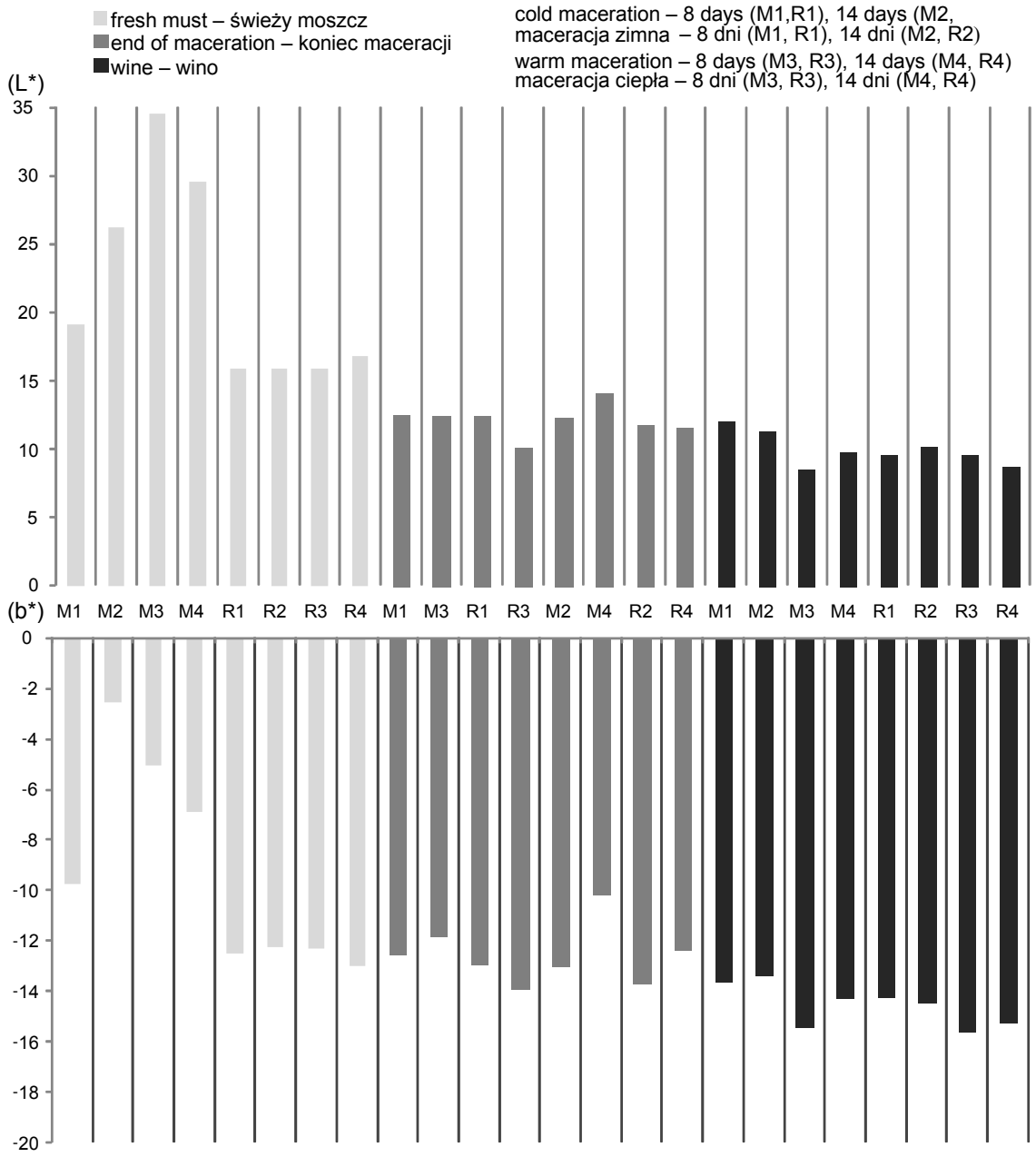

Fig. 1. Evolution of the parameters L* and b* in color fresh must, after completing maceration (respectively 8/14 days) and young wine varieties 'Monarch' and 'Regent'
Rys. 1. Kształtowanie się parametrów L* i b* w barwie świeżego moszczu, po ukończonej maceracji (odpowiednio 8/14 dni) i w młodym winie odmian 'Monarch' i 'Regent'

The must macerated at higher temperatures had a more intense colour, as compared to the cold macerated must and, in a way, the wine obtained was slightly darker. It was also noticed that the extension of the maceration process of up to 14 days at 18º–20ºC influenced an increase in the L* parameter, which shows that the colour of the must was lighter, as compared to the short maceration. On the other hand, for maceration at 7º–10ºC, the extension of this process resulted in the must becoming darker. The b* parameter defining the blue (–100) and the yellow colours (+100) showed negative values and their gradual decrease in the wine during the winemaking process. Final measurements showed a slightly greater intensity of the blue colour in young wine made at a higher temperature. According to Ochmian et al. (2013a), on the basis of the research results obtained, an increase in the content of blue-dyeing substances is favoured by lower temperatures.

CONCLUSIONS

1. The fruits from the analysed cultivars were characterised by a similar weight. A higher content of the extract was found in the fruits from the 'Regent' cultivar, while the 'Monarch' cultivar was characterised by a higher level of acids and a lower pH.
2. The wine obtained was characterised by lower acidity and higher pH as compared to the fruits. The highest acidity was observed for wines obtained from the 'Monarch' cultivar after an 8-day maceration process. An increase in the wine pH was promoted by a higher temperature and the extension of the maceration process.
3. The juice colour underwent continuous changes, especially during the first four days of pulp maceration and also during the young wine maturation process. The grape juice and wine became gradually darker, which was accompanied by extraction of compounds that changes the colour to blue, especially at higher temperatures.
4. Wine from 'Monarch' fruits processed at lower temperatures was characterised by the lightest colour and the lowest content of blue-dyeing compounds.

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Winegrowers Supplies – Vine variety information: Regent, http://www.winegrowers.info/varieties/Vine_varieties/Regent.htm, access: 25.02.2014.

Abstract. In recent years, an increase in the interest in vine growing and winemaking has been observed in Poland. The character and quality of Polish wine is shaped by a large number of factors defined by the French term *terroir*. The object of the research included fruits from the Monarch and Regent vine cultivars. The size and quality and size of grapes and the influence of the temperature and maceration time of fruits on the acidity, pH and the colour of the wine. The fruits of the cultivars under examination did not differ in the size of grapes. A higher content of the extract was found in the Regent cultivar fruits, while the Monarch cultivar was characterised by a higher level of acids and a lower pH. The highest acidity was observed for wines obtained from the Monarch cultivar after an 8-day maceration process. An increase in the wine pH was promoted by a higher temperature and the extension of the maceration process. The colour of the juice changed also after the completion of the pulp maceration, i.e. during the maturation of young wine. The grape juice and wine became gradually darker, which was accompanied by extraction of compounds changing the colour to blue, especially at higher temperatures.