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FERMENTATION TEMPERATURE AND DURATION EFFECT ON THE QUALITY AND ANTHOCYANIN CONTENT OF KADARKA WINE PRODUCED IN THE MINIȘ (MÉNES) WINE REGION

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Abstract

Grape growing and winemaking has a very long history around the world, where the geographical conditions and the climate is favourable. Romania could be listed among these regions, where can be found numerous red and white wine regions. Miniș region is famous for one of its red wines made from a traditional variety named Kadarka. The aim of the present experiment was to examine the quantitative and qualitative parameters of the wine made from Kadarka obtained under different conditions undertaken during fermentation on skins , and to knowledge how these parameters change with the different fermentation temperatures and duration and also measuring the anthocyanin content of the wine. The analyses quantitative and qualitative parameters were not changed under different tested conditions such as maceration time or temperature. However, the results showed that higher temperature (28°C) and shorter maceration period (12 days) gives a maximum anthocyanin content of 380 mg/L. The sensory evaluation of the resulted wines, revealed that a shorter maceration period and a lower temperature during fermentation on skins ensure better results for Kadarka variety.

Key words*: fermentation, Kadarka, Miniș, wine.*

INTRODUCTION

Winegrowing and winemaking have a very long history that it is cultivated back to 8000 years. This is one of the oldest plants grown by mankind. Grape and wine have great cult significance in many religions. Winemaking hides its beauty in complexity (Antoce & Stockley, 2019).

The geographical location, favourable climate and soil properties for grape growing, Romania plays a significant role in European wine production. The favourable climatic conditions, especially the rainfall and temperature during the growing season, benefits the production of quality wine. On the south-facing slopes of Romania's wine-growing regions, the grapes will ripen properly while their sugar and acidity will be balanced. Some "foreign" grape varieties show better development in Romania than in their native regions. For example, Muscat Ottonel is a grape variety bred in France, but in the Târnave wine region has an excellent taste, aroma, and develop in its wine (Balla, 2003; Csomós, 2003).

Based on data from the International Organization of Vine and Wine (O.I.V., 2007), the grape-growing area of Romania shows an increasing trend from 1986 to 2000 and a decreasing trend between 2001 and 2007. The areas changed as follows according to the past years: 243,000 ha between 1986–1990, 251,000 ha between 1991 and 1995, 252,000 ha between 1996 and 2000, 233,000 ha between 2001 and 2005, 213,000 ha in 2006 and 209,000 ha in 2007. This average area size accounts for approximately 1.7% of Romania's agricultural areas (O.I.V., 2007).

According to new research, a regulated and moderate consumption of wine has a positive effect on health (German & Walzem, 2000). This is due, among other things, to the high anthocyanin content of red wines (Garcia-Alonso et al., 2009).

Anthocyanin is an important quality parameter that contributes to antioxidant activity and gives an appealing colour to red grapes and wine (Mateus et al., 2002; Cliff et al., 2007; Pereira de Freitas et al., 2017). An anthocyanin-rich diet may prevent

inflammation and also protect against heart diseases (He et al., 2012; Yoo et al., 2013). A young red wine anthocyanin content can have an average of 500 mg/l, making them one of the important bioactive compounds in wine (Wu et al., 2006). Anthocyanins can also help in the prevention of colon cancer and colorectal cancer (Cooke et al., 2006; Jing et al., 2008; Somerset & Johannot, 2008), coronary heart diseases, and non-alcoholic liver diseases (Gronbaek et al., 2000; Newcomb et al., 1993; Anderson et al., 2005; Dunn & Schwimmer, 2008). One of the grape varieties with high anthocyanin content is Kadarka (Csávossy, 2003; González-Neves et al., 2012).

The origin of Kadarka is unclear, it is probably originating from Asia Minor, the convar. *pontica*, subconvar *balcanica*, provar. *mesocarp*, subprovar. belongs to the dalmatica group. South Slavs (Serbs, Ráks) brought it to the Miniș wine region while fleeing from the Turks. On the hillsides of the Mocrea settlement, "Turkish grappe" was grown B.C. a red wine grape variety, also called Negru moale in Romanian. In the middle of the 19th century, in Miniș and later in Gyorok, aszú was made from the shrunk berries of Kadarka. By 1872, it was one of the most widespread grape varieties in the wine region (Csávossy, 2003; González-Neves et al., 2012).

It is a less frost-resistant variety, it tolerates drought relatively well, and the vine grows strongly even in sand, the canes are thick, brownish-grey, striped, and have short internodes. The small, cobwebbed buds develop erect canes, why it is also suitable for training without support, requires short pruning. It does not require intense canopy management. Its shoot trip is characterized by a bronze-yellow-green colour and woolliness (Prohászka, 1986).

Leaves are medium-sized or large, shiny, dark green, thick-textured, and rough to the touch. Leaf blade 3-5 lobed, wavy with a woolly backside.

The cluster is cylindrical, dense, and medium-sized, prefers to be close to the ground.

The fruits are medium-sized, round, blue-black when fully ripe, thin-skinned, juicy, and characterized by a pleasant taste. It is late-ripening, fruits ripen in August, but it reaches technical maturity in mid-October. Sunlight requirement is high. It is usually abundant, but its productivity is strongly influenced by the conditions of fertility (Bényei et al., 1999).

It shows no resistance against diseases, especially in rainy seasons it is heavily damaged by fungal diseases. Because of its weak resistance against rot, it is often harvested already in September. In a good location and a favourable year, can reach 18-20°Bx must degrees.

The wine has a characteristically spicy aroma and flavour, is rich in tannic acid, has a ruby red colour, is thinner and fresher on looser soil, fuller-bodied on firmer soil, and richer in colourants, the latter being a characteristic of Minișı Kadarka (Cliff et al., 2007).

It is a component of "Miniș red", initially it was used at a rate of 70%, and currently 20-30% is added (Ştefan et al., 2017).

The aim of the experiment was to determine the influence of different fermentation temperatures and durations on the anthocyanin content and quality of the resulting Kadarka wines when using the technology of red wine production with fermentation on skins.

MATERIALS AND METHODS

The winemaking was carried out 26 km from Arad at Păuliș, Wine Princess S.R.L. The vineyard occupies an area of approximatively 70 ha. One of the most important varieties is Kadarka. The harvest began on 20th September, which ended on 17th March. The mash was pumped into the fermentation tanks. In each tank 7,990 L of mash was placed, leaving 20% fermentation space. Sulphite addition to the mash took place depending on the health of the grapes. In this case, were treated with 50 mg/L SO_2. The mash was cold-soaked for 48 hours at 9°C after was circulated with a pump three times a day in order to dissolve the colour. To start the fermentation and enzymatic treatment, the temperature was raised to 15°C. 23.97 g of Pectosol enzyme suspension per container was dissolved in 2 L of 20°C water and mixed with the mash. The fermentation temperature was controlled by computer for each fermentation tank.

During the winemaking, 17,000 kg of Kadarka grapes were processed. After removing the

stems and crushing the berries, 15,980 L of mash was fermented.
Two batches were separated K1 and K2. K1 was fermented at 25°C for 8 days, while K2 was fermented at 28°C for 12 days. Each batch was fermented in 10,000 L stainless steel wine tanks equipped with cooling dimpled jacket, and 20% of the tank was left empty for the fermentation. The fermentation of K1 was completed on 15th October and K2 on 19th October.
After the fermentation was finished the sugar content was measured and then the free-run wine was separated from the marc, then it was pressed at a maximum of 1.5 bar. The press wine and the free-run wine were then blended at a proportion of 80/20, and 11,900 L of wine was produced.
On 20-21th of December, when the malolactic fermentation ended, the first organoleptic examination was carried out and the basic laboratory tests were made (alcohol, titratable acid, volatile acid, free sulphur content, pH level and anthocyanin content).
The new wine was put into barrique barrels. The wine was aged for three months, after a second organoleptic examination and laboratory tests were made.
For the evaluation, we used a 100-point rating system issued by the International Organisation of Vine and Wine (O.I.V.). Besides the colour, clarity, intensity, aroma, bouquet and taste the overall impression and harmony were rated.

RESULTS AND DISCUSSIONS

The result of the qualitative examination of Kadarka grapes before processing was 225.32 g/L sugar content, while the titratable acid content was 7.3 g/L expressed in tartaric acid. The wine's sugar content was measured 8 days after the fermentation stopped, the results were between 3.9-4.0 g/L, since both variants were fermented as a dry wine.
The effect of fermentation temperature and maceration period on Kadarka wines alcohol content is presented in Figure 1.
There is a difference of 0.2 volume % between the variants fermented for 8 days and 25°C and the variants fermented for 12 days and 28°C (Figure 1). The K1 has an alcohol content of 13% by volume and K2 had an alcohol content of 13.2% by volume on 20th of December. It can be determined that the results measured on 15th March, after three months of maturation, did not show any deviation either, the measured alcohol content did not change in the case of both variants.

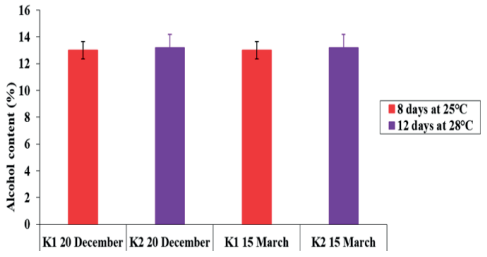

Figure 1. Changes in alcohol content on different temperatures in K1 and K2 inox tanks

The effect of fermentation temperature and maceration period on Kadarka wines titratable acidity is presented in Figure 2.
The titratable acidity of the wine fermented for 8 days at 25°C is 6.2 g/L, while the titratable acidity of the wine fermented for 12 days at 28°C is 6.4 g/L, which was measured on 20th of December. The analysis on 15th March recorded the following titratable acidity results: K1 6 g/L and K2 6.1 g/L. After three months of maturation there is a difference of 0.1 g/L between the two tanks. The variant fermented for a longer time and at a higher temperature had higher titratable acid content in both tests. At the same time, a decrease in acidity can be observed in the case of both variants during maturation, which was caused by the precipitation of tartaric acid during malolactic fermentation.

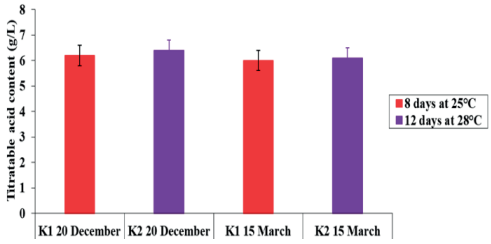

Figure 2. Changes in titratable acid content in wines fermented at different temperatures in K1 and K2 inox tanks

The effect of changes in fermentation temperature and duration on the volatile acid content of Kadarka

Under our experimental conditions the results of the volatile acid content differ slightly between the K1 and K2 (Figure 3). The first laboratory test gave the following results: the volatile acid content of wine fermented for 8 days at 25°C was 0.52 g/L, and the volatile acid content of wine fermented for 12 days at 28°C was 0.61 g/L. The results of March: K1 0.54 g/L, the K2 0.63 g/L, there is also a difference. The results show that the volatile acid content of both variants increased by 0.02 g/L during the three-month maturation period.

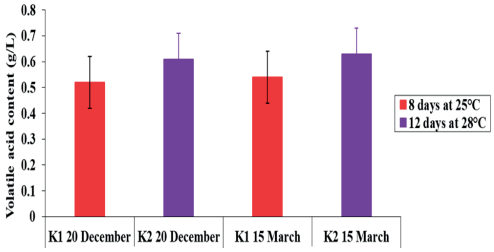

Figure 3. Changes in volatile acidity in wines fermented at different temperatures in K1 and K2 inox tanks.

The effect of fermentation temperature and maceration period on Kadarka wines on free sulphur dioxide is presented in Figure 4.

During the analysis on 20th of December, 16 mg/L sulphur dioxide content was measured for K1 and 21 mg/L for the K2 variant. In the laboratory test on 15th March 21 mg/L was measured from the wine fermented for 8 days at 25 °C and 19 mg/L of the K2 fermented for 12 days at 28 °C (Figure 4).

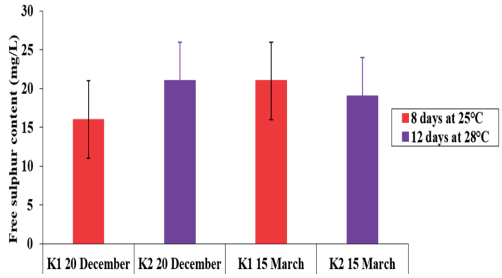

Figure 4. Changes in free sulphur dioxide in wines fermented at different temperatures in K1 and K2 inox tanks

The effect of fermentation temperature and maceration period on Kadarka wines on pH is presented in Figure 5.

The Kadarka pH content values were between 3.0 and 3.1 (Figure 5). The pH content of K1 was 3.1 and K2, 3 at the time of the first laboratory test. During the March test, the pH content showed the same results as the first time. So, during the three-month storage of Kadarka, the pH content of the samples did not change.

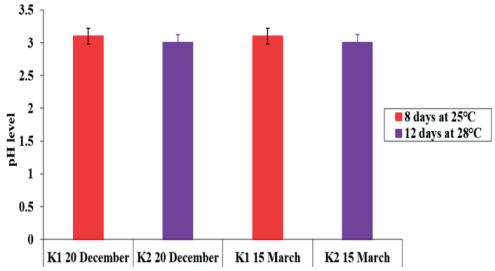

Figure 5. Changes in pH level in wines fermented at different temperatures in K1 and K2 inox tanks

The effect of fermentation temperature and maceration period on Kadarka wines on anthocyanin content is presented in Figure 6.

It is clear that there is a difference between the K1 and K2 variant in terms of the anthocyanin content (Figure 6), one of the significant factors determining the colour of red wines. The anthocyanin content of the wine fermented for 8 days at 25°C was 345 mg/L, while the anthocyanin content of the wine fermented for 12 days at 28°C was 380 mg/L after malolactic fermentation. The March results were as follows: K1 was 320 mg/L and K2 was 357 mg/L. Although the anthocyanin content of the variant fermented at a higher temperature and for a longer time was higher, it showed a decrease of 23 mg/L during maturation. The decrease can also be attributed to the anthocyanin content of K1. The formation of the anthocyanin tannin complexes during wine maturation decrease the free anthocyanin concentration.

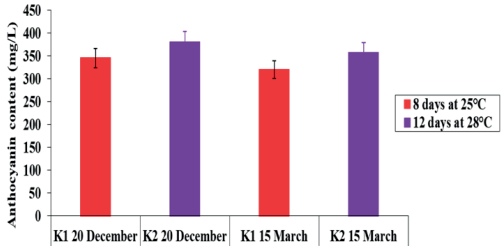

Figure 6. Changes in anthocyanin content in wines fermented at different temperatures in K1 and K2 inox tanks

The results of the organoleptic tests of Kadarka Examining the results of the first sensory test (Figure 7), the K1, fermented for 8 days and at 25°C, received a higher evaluation. The K1 variant scored lower than K2 for the colour and clarity parameters, which was also associated with lower anthocyanin content. However, the aroma of the K2 variant was not favoured by the longer maturation time (12 days) or the higher temperature (28°C), so its evaluation was lower than the K1. There is only a difference of 1 point between the taste and general impression in the case of the two variants. The total scores of the evaluation: K1 81 points and K2 80 points.

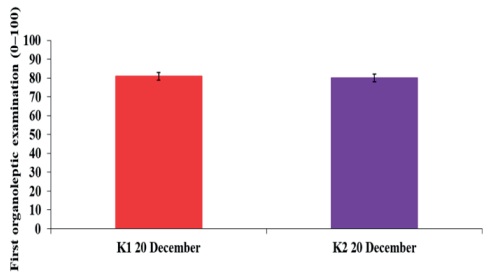

Figure 7. Scores of the first organoleptic examination obtained by wines fermented at different temperatures in K1 and K2 inox tanks

During the examination on 15th March, a difference of 2 total points can be seen between the variants, as in the first organoleptic examination (Figure 8). During barrel ageing, the intensity of the colours decreased, but the quality of the colours improved, which is also shown by the evaluation of the March test. In the case of both variants, the scores of the colour and clarity parameters increased. In addition to the aroma, the bouquet of wines appeared, and this parameter improved, but the K1 was considered better by the judges, it received 26 points for this parameter. Regarding the taste and general impression, the K2 developed less during the maturation, reaching the same average score as the K1, 45 points. The total score: K1 88 points and K2 variant 86 points. K1 variant fermented for a shorter time (8 days) and at a lower temperature (25°C) proved to be of better quality.

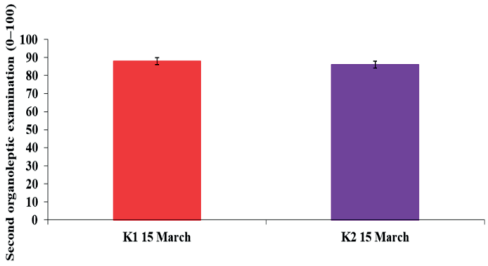

Figure 8. Scores of the second organoleptic examination obtained by wines fermented at different temperatures in K1 and K2 inox tanks

CONCLUSIONS

From the present study we can conclude that, the different temperatures and length of fermentation did not have a significant effect on the wine's alcohol, titratable acid, volatile acid, free sulphur content or pH level, but still these measurements were important to complete because they are the basic measurements regarding winemaking.

In terms of anthocyanin content, better results were achieved with a higher temperature and a longer fermentation period.

Regarding the organoleptic evaluation, K1 with a lower temperature and a shorter fermentation period scored higher (88 points). This grape variety genetically produces less anthocyanin, but is excellent and characteristic in its flavour and aroma substances, therefore, to preserve the aroma substances, fermentation at a lower temperature is recommended.

REFERENCES

Anderson, J.C., Alpern, Z., Sethi, G., Messina, C.R., Martin, C., Hubbard, P.M., Grimson, R., Ells, P.E., &

Shaw, R., D. (2005). Prevalence and risk of colorectal neoplasia in consumers of alcohol in a screening population. *The American Journal of Gastroenterology*, *100*, 2049–2055.

Antoce, A.O., & Stockley, C. (2019). An overview of the implications of wine on human health, with special consideration of the winederived phenolic compounds. *AgroLife Scientific Journal*, *8*(1), 21–34.

Balla, G. (2003). *Wine production management in an integrated system in the Miniş-Măderat vineyard (Managementul producţiei vitivinicole în sistem integrat în podgoria Miniş-Măderat)*. Timişoara, Doctoral Thesis.

Bényei, F., Lőrinzc A., & Sz. Nagy L. (1999). *Viticulture (Szőlőtermesztés)*. Budapest, HU: Mezőgazda Publishers.

Cliff, M.A., King, M.C., & Schlosser, J. (2007). Anthocyanin, phenolic composition, colour measurement and sensory analysis of BC commercial red wines. *Food Research International*, *40*(1), 92–100.

Csávossy, Gy. (2003). *Transylvania, the land of good wines (Jó boroknak szép hazája, Erdély)*. Budapest, HU: Mezőgazda Publishers.

Csomós, E. (2003). *Comparative analysis of Hungarian white and red wines in terms of free amino acid and biogenic amine content (Magyar fehér- és vörösborok összehasonlító vizsgálata a szabad aminosav és a biogén amin tartalom alapján)*. Budapest, Doctoral Thesis.

Dunn, W., Xu, R.H., & Schwimmer, J.B. (2008). Modest wine drinking and decreased prevalence of suspected nonalcoholic fatty liver disease. *Hepatology*, *47*, 1947–1954.

Garcia-Alonso, M., Minihane, A.-M., Rimbach, G., Rivas-Gonzalo, J., & de Pascula-Terasa, S., (2009). Red wine anthocyanins are rapidly absorbed in humans and affect monocyte chemoattractant protein 1 levels and antioxidant capacity of plasma. *The Journal of Nutritional Biochemistry*, *20*(7), 521–529.

German, J.B., & Walzem, R.L., (2000). The Health Benefits of Wine. *Annual review of nutrition*, *20*, 561–593.

González-Neves, G., Gil, G., Favre, G., & Ferrer, M. (2012). Influence of grape composition and winemaking on the anthocyanin composition of red wines of Tannat. *International Journal of Food Science & Technology*, *47*, 900–909.

Gronbaek, M., Becker, U., Johansen, D., Gottschau, A., Schnohr, P., Hein, H.O., Jensen, G., & Sorensen, T.I.A. (2000). Type of alcohol consumed and mortality from all causes, coronary heart disease, and cancer. *Annals of Internal Medicine*, *133*, 411–419.

He, F., Liang, N.-N., Mu, L., Pan, Q.-H., Wang, J., Reeves, M.J., & Duan, C.-Q. (2012). Anthocyanins and Their Variation in Red Wines I. Monomeric Anthocyanins and Their Color Expression. *Molecules*, *17*(2), 1571–1601.

International Organisation of Vine And Wine (O.I.V.), (2007). Structure of the world vitivinicultural industry in 2007, http://news.reseau-concept.net/images/oiv_uk/Client/Statistiques_commentaires_annexes_2007_EN.pdf.

Jing, P., Bomser, J.A., Schwartzt, S.J., He, J., Magnuson, B.A., & Giusti, M.M. (2008). Structure-function relationships of anthocyanins from various anthocyanin-rich extracts on the inhibition of colon cancer cell growth. *Journal of Agricultural and Food Chemistry*, *56*, 9391–9398.

Mateus, N., Machado, J.M., & de Freitas, V. (2002). Development changes of anthocyanins in Vitis vinifera grapes grown in the Douro Valley and concentration in respective wines. *Journal of the Science of Food and Agriculture*, *82*, 1689–1695.

Newcomb, P.A., Storer, B.E., & Marcus, P.M. (1993). Cancer of the large-bowel in women in relation to alcohol-consumption: a case-control study in Wisconsin (United-States). *Cancer Causes Control*, *4*, 405–411.

Pereira de Freitas, V.A., Fernandes, A., Oliveira, J., Teixeria, N., & Mateus, N., (2017). A review of the current knowledge of red wine colour. *OENO One*, *51*(1), 1–15.

Prohászka, F. (1986). *Grapes and wine (Szőlő és bor)*. Budapest, Mezőgazdasági Publisher.

Somerset, S.M., & Johannot, L. (2008). Dietary flavonoid sources in Australian adults. *Nutrition and Cancer*, *60*, 442–449.

Ştefan, P., Mann, S., Fintineru, G., & Creţu, R.C., (2017). Study regarding the situation of wine producers in Romania. *Scientific Papers. Series Management, Economic Engineering in Agriculture and rural development*, *17*(3), 391–396.

Yoo, Y., Saliba, A., MacDonald, J., Prenzel, P., & Ryan, D., (2013). A cross-cultural study of wine consumers with respect to health benefits of wine. *Food Quality and Preference*, *28*(2), 531–538.