The impact of different commercial yeasts on quality parameters of Montenegrin red wine – Vranac and Kratošija

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Abstract

The influence of three different commercial yeasts (BDX, BM4X4 and ICV D21), on quality parameters of wines from varieties Vranac and Kratošija were studied during two consecutive vintage years. The basic quality parameters of grape must (sugar content, total acidity, pH, tartaric and malic acid) and the wine quality parameters (alcohol content, total dry extract, glycerol, pH, total polyphenols and total anthocyanins) were determined after each phase of fermentations: after alcoholic and malolactic fermentation as well as after three months of wine maturation. There are significant differences in quality parameters of grapes and wines between vintages 2012 and 2013. Higher content of total dry extract and glycerol in wines after completion of alcoholic fermentation was achieved in vintage 2013. In vintage 2013, the highest content of total polyphenols (3.75 and 2.98 g L⁻¹) and anthocyanins (1247 and 713 mg L⁻¹) in Vranac wine after malolactic fermentation and after three months of maturation, were achieved by yeast BM4X4, while the highest total polyphenols (2.14 and 1.92 g L⁻¹ and anthocyanins content (527 and 262 mg L⁻¹, respectively) was achieved by BDX strain in Kratošija wine. The results of sensory analysis showed no significant differences between the used yeast strains and studied vintages, 2012 and 2013. Surprisingly, the wines of vintage 2012 are even slightly better sensory evaluated.

Introduction

Wine styles are defined by complex and highly diverse chemical compositions. Amongst the myriad of grape and wine processing options known to influence wine style, choice of yeast strain represents a low-cost opportunity to broaden the spectrum of wine flavour profiles possible from a single vineyard or variety [1]. There are hundreds of different commercially available wine yeast strains that, potentially, provide a means by which winemakers can tailor their wines for different consumer market segments. Saccharomyces cerevisiae is a yeast species specialized in metabolizing media with high sugar contents and small quantities of nitrogenous compounds. In the past, musts were fermented by yeast indigenous to the grape microbiota, but nowadays most are inoculated with selected yeast strains preserved in dried form. Traditionally, yeasts have been selected for their fermentative power, suitable fermentative kinetics at different temperatures, low acetic production and resistance to sulphur dioxide. However, new selection criteria emerged and role of yeasts in winemaking involved improvement of wine in terms of their colour, aroma, structure and other technological properties [2,3] concluded that the role of yeast is complex and strongly associated with wine quality, and that it is becoming even more important to select yeast that are right for each kind of wine, region and even microclimate.

Wine phenolics are extracted from grape skins and seeds during fermentation, interact with insoluble cell wall material from the grapes [4,5], and undergo a range of chemical transformations during maturation. Selection of yeast strain has been shown to impact on the concentration of anthocyanins [6,7] and other phenolics [6,8,9] in finished wine. The work combined analyses of wine total polyphenols, total anthocyanins, total dry extract, alcohol and sensory analysis. The impact of yeast upon wine sensory properties in red wine play a role in the perception of red and dark fruit aromas [10,11]. Also, yeasts have great influence on glycerol production which is influenced by many growth and environmental factors [12]. Several studies have described the effect of yeast strain on glycerol production [13,14] and it appears to be one of the key factors impacting glycerol production. The amount of glycerol produced varies with the type of yeast used, with sugar content and the grape variety. This manuscript describes the results of four fermentation experiments with different commercial yeasts, across two vintages and within two grape varieties, which emphasize the significant impact that choice of yeast strain can have upon red wine chemical composition.

Current viticulture and wine production in Montenegro is based mainly on presumed autochthonous grapevine cultivars, such as Vranac, Kratošija, Krstač, and Žižak. The dominant cultivars for red wine production are Vranac and Kratošija. Significantly less prevalent is Krstač, used for white wine production, while no commercial wine is produced from Žižak. Vranac and Kratošija are the most important grapevine varieties for production of red wines in Montenegro.
Vranac wine became a national brand as well as the most recognizable and the best product of the company "13. Jul Plantaže". Kratošija is a Montenegrin autochthonous variety for production of red wines, grown for centuries in Montenegro, which falls into the category of recommended varieties for quality wine. According to many literature data, Kratošija variety appeared earlier and was introduced into cultivation quite earlier than Vranac [15]. Wines of these varieties are of premium quality, Vranac has dark red ruby colour, full body, fruity taste and pleasant astringency and it has potential of lying down and maturing. Kratošija wine is characterized by an intense ruby-red colour and aroma of red berry fruits and an extremely pleasant taste; it has a light and harmonious structure and smooth finish.

**Material and methods**

The trial was carried out during the 2012 and 2013 growing seasons. Autochthonous grapevine varieties Vranac and Kratošija were planted in the commercial vineyard of the company "13. Jul Plantaže" in the Cemovsko field in sub-region Podgorica (Montenegro).

Grapes of both varieties were planted in 2003, grafted onto Paulsen 1103 rootstock, trained to a modified single Guyot training system, rows spaced 2.6 m apart and with 0.7 m between plants in the row. All standard agro-technical operations were applied and vineyards were in good and healthy condition. Wines were produced at microvinification scale in the experimental cellar at the company "13. Jul Plantaže". At harvest, grapes from both examined varieties were harvested manually and transported to the experimental cellar. Alcoholic fermentation of trials was performed in PVC barrels using traditional method. For the vinification of control wines, an average grape sample of both varieties trials was performed in PVC barrels using traditional method. For the harvest, grapes from both examined varieties were harvested manually and transported to the experimental cellar. Alcoholic fermentation of trials was performed in PVC barrels using traditional method. For the vinification of control wines, an average grape sample of both varieties was 100 kg of grapes. For trials with yeast addition we used an average grape sample of 400 kg for both varieties. Potassium metabisulphite, purchased from Agroterm KFT, Hungary was added; 8 g 100 kg-1 of grape sample of 400 kg for both varieties. Potassium metabisulphite, purchased from Agroterm KFT, Hungary was added; 8 g 100 kg-1 of grape sample of 400 kg for both varieties. Potassium metabisulphite, purchased from Agroterm KFT, Hungary was added; 8 g 100 kg-1 of grape sample of 400 kg for both varieties. Potassium metabisulphite, purchased from Agroterm KFT, Hungary was added; 8 g 100 kg-1 of grape sample of 400 kg for both varieties. Potassium metabisulphite, purchased from Agroterm KFT, Hungary was added; 8 g 100 kg-1 of grape sample of 400 kg for both varieties. Potassium metabisulphite, purchased from Agroterm KFT, Hungary was added; 8 g 100 kg-1 of grape sample of 400 kg for both varieties. Potassium metabisulphite, purchased from Agroterm KFT, Hungary was added; 8 g 100 kg-1 of grape sample of 400 kg for both varieties. Potassium metabisulphite, purchased from Agroterm KFT, Hungary was added; 8 g 100 kg-1 of grape sample of 400 kg for both varieties. Potassium metabisulphite, purchased from Agroterm KFT, Hungary was added; 8 g 100 kg-1 of grape sample of 400 kg for both varieties. Potassium metabisulphite, purchased from Agroterm KFT, Hungary was added; 8 g 100 kg-1 of grape sample of 400 kg for both varieties. Potassium metabisulphite, purchased from Agroterm KFT, Hungary was added; 8 g 100 kg-1 of grape sample of 400 kg for both varieties. Potassium metabisulphite, purchased from Agroterm KFT, Hungary was added; 8 g 100 kg-1 of grape sample of 400 kg for both varieties. Potassium metabisulphite, purchased from Agroterm KFT, Hungary was added; 8 g 100 kg-1 of grape sample of 400 kg for both varieties. Potassium metabisulphite, purchased from Agroterm KFT, Hungary was added; 8 g 100 kg-1 of grape sample of 400 kg for both varieties. Potassium metabisulphite, purchased from Agroterm KFT, Hungary was added; 8 g 100 kg-1 of grape sample of 400 kg for both varieties. Potassium metabisulphite, purchased from Agroterm KFT, Hungary was added; 8 g 100 kg-1 of grape sample of 400 kg for both varieties. Potassium metabisulphite, purchased from Agroterm KFT, Hungary was added; 8 g 100 kg-1 of grape sample of 400 kg for both varieties. Higher content of total dry extract and glycerol in wines after completion of alcoholic fermentation was achieved in vintage 2013 (Table 2).

**Table 1. Quality parameters of Vranac and Kratošija grapes.**

| Grape variety | Harvest season | Sugar (%) | Total acidity (g L⁻¹) | Tartaric acid (g L⁻¹) | pH | Malic acid (g L⁻¹) | Total polyphenols (g L⁻¹) | Total anthocyanins (mg L⁻¹) |
|---------------|----------------|-----------|----------------------|----------------------|----|-------------------|--------------------------|---------------------------|
| Vranac        | 2012           | 18.8      | 3.61                 | 4.84                 | 3.70| 1.10              | 0.12                     | 19.5                      |
| Vranac        | 2013           | 21.2      | 4.63                 | 5.49                 | 3.70| 1.00              | 0.93                     | 205.5                     |
| Kratošija     | 2012           | 21.5      | 5.73                 | 3.64                 | 3.60| 1.80              | 0.49                     | 60.0                      |
| Kratošija     | 2013           | 22.6      | 6.23                 | 4.05                 | 3.59| 3.00              | 0.45                     | 21.0                      |

**Table 2. Chemical parameters after alcoholic fermentation for Vranac and Kratošija wine.**

| Variety | Yeast | Alcohol (vol. %) | Total dry extract (g L⁻¹) | Glycerol (g L⁻¹) |
|---------|-------|------------------|---------------------------|------------------|
|         |       | 2012             | 2013                      | 2012             | 2013 | 2012           | 2013 |
| Vranac  | Control | 12.59            | 13.38                     | 24.20            | 29.62 | 8.19          | 11.21 |
|         | BDX    | 12.41            | 13.69                     | 25.03            | 30.40 | 9.18          | 10.56 |
|         | D21    | 12.48            | 14.04                     | 24.07            | 31.16 | 8.37          | 10.44 |
|         | BM4x4  | 12.48            | 13.98                     | 24.57            | 30.52 | 8.37          | 10.07 |
| Kratošija | Control | 13.58            | 13.01                     | 24.28            | 28.69 | 9.18          | 10.58 |
|         | BDX    | 13.84            | 13.08                     | 26.28            | 28.37 | 9.22          | 9.11  |
|         | D21    | 13.84            | 13.24                     | 24.69            | 29.30 | 8.24          | 9.17  |
|         | BM4x4  | 13.77            | 13.11                     | 26.04            | 28.15 | 8.69          | 8.34  |
After alcoholic fermentation, there were no significant differences in achieved alcohol content between used commercial yeast and control wine as well. In the vintage of 2013 the highest content of total dry extract was achieved by D21 yeast in both varieties, while in 2012 it was by BDX yeast. Higher content of total polyphenols and anthocyanins is characteristic of Vranac variety, comparing to Kratošija which achieves significantly lower content of these compounds. Higher content of these compounds in wines after completion of alcoholic fermentation was also achieved in vintage 2013 (Table 3). There were no significant differences between BDX and D21 yeast in total polyphenols content for both vintages in Vranac wines. In the vintage of 2013 there were not also significant differences between used yeast in achieved content of total anthocyanins, while control wine had much lower anthocyanins content. In 2012 vintage BDX yeast significantly stressed out in achieving anthocyanins content, while control wine and wine with other yeast had similar anthocyanins content values. Regarding to Kratošija wine, in this phase wine where D21 commercial yeast were used, showed the highest potential in accumulation of total polyphenols and anthocyanins in both vintages. Also, control wines had significantly lower content of these compounds for both vintages. However, these data are susceptible to changes and in these phase, cannot be considered as final indicator if wine quality.

After maturation

In vintage 2013, the highest content of total dry extract, total polyphenols and total anthocyanins of Vranac wine after malolactic fermentation and after three months of maturation, were achieved by yeast BM4x4 (Table 4). There were no significant differences between alcohol content within treatments. Wines from 2012 are slightly better sensory evaluated and it is shown that D21 and BDX yeast had similar and significantly higher evaluating marks. The lowest sensory evaluation showed control wine. In Kratošija wine the highest total polyphenols and anthocyanins content was achieved by BDX yeast in vintage 2013, while in 2012 the best results showed commercial yeast D21. Regarding to sensory evaluation it is shown that the highest marks got wines where D21 and BM4x4 were used.

**Conclusion**

Results of this study highlight the importance of different commercial yeast inoculation as a tool to modulate red wine composition. Regarding to Vranac wine, it is noticed that inoculation with yeast BM4X4 gave wine with highest total polyphenol and total anthocyanin content, while wine with commercial yeasts BDX had the highest total dry extract content. As sensory characteristics are the most important, we concluded that D21 and BDX improved Vranac wine flavour and aroma. In Kratošija wine the highest total polyphenols and anthocyanins content was achieved by BDX yeast in vintage 2013, while in 2012 the best results showed commercial yeast D21. Regarding to sensory evaluation it is shown that the highest score got wines produced by D21 and BM4x4 yeasts.

In conclusion, by taking a broad approach to characterising the impacts of different wine yeasts on red wine composition we demonstrate a clear wine yeast impact ‘signature’ despite using different grapes from different vintages. The use of commercial strains of *S. cerevisiae* is becoming a common practice in winemaking. This practice ensures a reproducible product, reduces the risk of wine spoilage and allows a more predictable control of fermentation and quality.

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### Table 3. Total polyphenols and total anthocyanins contents after alcoholic fermentation for Vranac and Kratošija wine.

| Variety | Yeast | Total polyphenols (g L⁻¹) | Total anthocyanins (mg L⁻¹) |
|---------|-------|---------------------------|-----------------------------|
|         |       | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 |
| Vranac  | Control | 2.62 | 2.20 | 862  | 729  |
|         | BDX   | 3.05 | 3.75 | 1247 | 1229 |
|         | D21   | 2.81 | 3.73 | 889  | 1158 |
|         | BM4x4 | 2.35 | 3.67 | 766  | 1260 |
| Kratošija | Control | 1.30 | 1.28 | 310  | 330  |
|         | BDX   | 1.86 | 2.06 | 415  | 516  |
|         | D21   | 1.91 | 2.14 | 526  | 577  |
|         | BM4x4 | 1.92 | 1.87 | 453  | 523  |

### Table 4. Chemical parameters and sensory evaluation in Vranac and Kratošija wine.

| Variety | Yeast | Alcohol (vol. %) | Total dry extract (g L⁻¹) | Total polyphenols (g L⁻¹) | Total anthocyanins (mg L⁻¹) | Sensory analysis (score) |
|---------|-------|-----------------|---------------------------|---------------------------|-----------------------------|--------------------------|
|         |       | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 |
| Vranac  | Control | 12.53 | 12.94 | 23.70 | 29.70 | 1.63 | 1.95 | 595.5 | 522.0 | 72.33 | 71.50 |
|         | BDX   | 12.44 | 13.33 | 26.10 | 30.05 | 1.68 | 2.32 | 463.5 | 574.5 | 77.00 | 75.60 |
|         | D21   | 12.43 | 13.84 | 24.80 | 29.40 | 2.21 | 2.98 | 508.5 | 730.5 | 77.00 | 76.90 |
|         | BM4x4 | 12.53 | 13.84 | 24.20 | 30.70 | 2.31 | 2.42 | 427.5 | 522.0 | 74.33 | 75.00 |
| Kratošija | Control | 13.44 | 12.81 | 24.20 | 27.04 | 1.28 | 1.33 | 132.0 | 222.0 | 77.00 | 70.00 |
|         | BDX   | 13.69 | 12.91 | 26.10 | 27.60 | 1.93 | 1.92 | 136.5 | 262.5 | 72.67 | 71.50 |
|         | D21   | 13.70 | 12.95 | 26.10 | 28.10 | 1.37 | 1.33 | 180.0 | 258.0 | 80.70 | 79.00 |
|         | BM4x4 | 13.90 | 12.73 | 25.50 | 26.10 | 1.71 | 1.75 | 181.5 | 186.0 | 79.60 | 78.00 |

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