BIO Web of Conferences **5**, 01006 (2015)
DOI: 10.1051/bioconf/20150501006

Impact of grape cluster defoliation on TDN potential in cool climate Riesling wines

Armin Schüttler[1], Caroline Guthier[1,2], Manfred Stoll[2], Phillippe Darriet[3,4], and Doris Rauhut[1]

[1] Hochschule Geisenheim University, Department of Microbiology and Biochemistry, Von-Lade-Str. 1, 65366 Geisenheim, Germany
[2] Hochschule Geisenheim University, Department of General and Organic Viticulture, Von-Lade-Str. 1, 65366 Geisenheim, Germany
[3] Univ. de Bordeaux, Institut des Sciences de la Vigne et du Vin, Unité de recherche Œnologie, EA 4577, 210 Chemin de Leysotte, 33882 Villenave d'Ornon, France
[4] INRA, Institut des Sciences de la Vigne et du Vin, USC 1366 Oenologie, 33882 Villenave d'Ornon, France

Abstract. Many cool climate grape vine growing regions are and will be affected by the global climate change. It is likely that increasing temperatures, as well as changing precipitation pattern will impact the wines' composition and wine styles. In the last decades the sensory concept of German Riesling wines was considered to represent fresh and fruity notes. However, aged wines of this variety are characterized by petrol like aroma, which is not appreciated in modern Riesling wines. The C13-norisoprenoid 1,1,6-trimethyl-1,2-dihydronaphthalene (TDN) is considered to be the marker compound for this undesired sensory impression. The biogenesis of this compound is impacted by grape vine growth conditions. Wines made from Riesling grapes grown in warmer climates have higher concentrations of TDN. Therefore "TDN management" will be one of the most challenging tasks in viticulture in Riesling growing regions in general and particularly in cool climate regions. Two approaches considered are the canopy management of the grape vines as well as an appropriate selection of yeast strain for alcoholic fermentation. Therefore, the aim of this project was to study the impact of grape zone defoliation on potential TDN concentrations in grapes, must and finished wines under cool climate conditions, in example of regional conditions of the landmark Hessische Bergstraße, in combination with the usage of two commercially available yeast strains during alcoholic fermentation. The experiment consisted of four treatments in a balanced incomplete block design, grape zone defoliation at berry set on the eastern side of the canopy, grape zone defoliation at berry set on eastern and western side of the canopy, grape zone defoliation at veraison on eastern and western side of the canopy, and a non-defoliated treatment. The treatments and repetitions were harvested separately, pressed, and then fermented with two different commercial *Saccharomyces cerevisiae* strains. Grape juice samples, pressed musts and wines were analysed for potential TDN using GC–MS. Furthermore, the wines were submitted to sensory analysis. Significant differences were shown for TDN potential in grape musts and finished wines of defoliation treatments. Moreover, sensory differences were also shown for young wines. The results demonstrate that canopy management as well as yeast strains are impacting factors on "TDN management" and are considered to be tools for avoiding undesired aging notes.

1. Introduction

Many cool climate grape vine growing regions are and will be affected by the global climate change [1]. It is likely that increasing temperatures, as well as changing precipitation pattern will impact the wines' composition and wine styles [2]. In the last decades the sensory concept of German Riesling wines was considered to represent fresh and fruity notes. However, aged wines of this variety are characterized by petrol like aroma, which is not appreciated in modern Riesling wines. The C13-norisoprenoid 1,1,6-trimethyl-1,2-dihydronaphthalene (TDN) is considered to be the marker compound for this undesired sensory impression (Simpson).

Norisoprenoids are breakdown products of tetraterpenic carotenoid compounds which play a manifold role in biochemical signalling processes such as pheromone properties or hormone like growth regulation in plants [3]. The C13-norisoprenoid TDN is transformed into glycosidic bound non-volatile precursors by the plant. It then is liberated during bottle aging by acidic hydrolysis and complex rearrangements [4–6]. The biogenesis of these classes of compounds in general and particularly TDNis impacted by grape vine growth conditions [7]. Wines made from Riesling grapes grown in warmer climate have higher concentrations of TDN [8]. Moreover, vineyard management impacts on the development of this compound [9,10]. In addition, grape vine clones and yeast strains also seem to have an impact on TDN concentrations [11]. Therefore, "TDN management" will be one of the most challenging tasks in viticulture in Riesling growing regions in general and particularly in cool climate regions regarding to rising temperatures due to climate change. The canopy management of the grape vines as well as an appropriate selection of yeast strain during alcoholic fermentation are two considered approaches to tackle excessive TDN concentrations in Riesling wines.

2. Material and methods

2.1. Experimental vineyard

The vineyard was located in Heppenheim, Germany (Heppenheimer Stemmler) and was planted with Riesling vines in 1982 on sandy loam. The vines were trained to a VSP-type trellis system at six to eight canes Interrow distance was 1.60 m whereas intervine distance was 1.10 m resulting in a surface of 1.76 m^2/vine. In four rows four treatments were established in threefold repetition according to an incomplete randomised block design. The first treatment was not defoliated representing the control (CTR), the second treatment was defoliated in the grape cluster zone after bloom (June 11th) only on the eastern side (LREE), the third treatment was defoliated in the grape cluster zone after blossom (June 11th) on the eastern and western side of the canopy (LREB), and the fourth treatment was defoliated in the grape cluster zone at *veraison* (September 5th) on the eastern and western side of the canopy (LRLB). Each treatment consisted of 16 vines. In order to regulate yield all but two clusters per shoots were removed for all treatments at berry set.

2.2. Experimental winemaking

Harvest date was October 16th. Each treatment and replicate, in total 16 lots, was harvested and pressed separately using a 20 kg press. Grape juice was clarified by sedimentation in 48 h. Then the clarified juice of one treatment was mixed and then aliquoted into 750 mL bottles and inoculated using two commercial yeast strains and adding Vitamin B1 and diammonium phosphate. The fermentation was monitored by determining the loss of carbon dioxide.

2.3. Analysis of TDN

Analysis of TDN and TDN-glycosides was carried out using GC–MS after SPE sample preparation [12].

3. Results and discussion

3.1. TDN potential in grape juice

The four grape juices without leaf removal (CTR) showed the lowest TDN potential of 63 ± 3 µg/L, whereas the treatment with the leaves removed on both sides of the canopy at a early stage of berry development (LREB) showed the highest TDN potential of 154 ± 35 µg/L. Both the treatment defoliated at an early stage of berry development on the eastern side of the canopy (LREE) and the one defoliated at *veraison* on both sides of the canopy (LRLB) also showed higher TDN potential (112 ± 9 µg/L and 119 ± 6 µg/L, respectively) compared to control treatment, but lower TDN levels compared to the LREB treatment.

3.2. TDN potential in wines

After fermentation, the TDN potential pattern was highest for the treatments being defoliated on both sides of the canopy (LREB, LRLB) for yeast strain A by showing TDN potential of 135 µg/L and 132 µg/L, respectively. This was also the case for yeast strain B (111 µg/L and 100 µg/L, respectively). Furthermore, TDN-potential in the not defoliated control (CTR) was lowest for yeast B (56 µg/L), while lowest TDN potential obtained from yeast B for LREE equalled TDN potential from yeast B for CTR (63 µg/L and 69 µg/L, respectively) and was well under TDN potential from LREE wines obtained with the same yeast (82 µg/L).

3.3. Discussion

The here presented results give evidence that the TDN potential in grape must is highly correlated with the sun exposure of grape clusters. These results also show that the TDN potential does not necessarily depends on the timing of leaf removal, which is generally in accordance with earlier studies [9,13]. However, the TDN potential pattern corresponds well to that of the grape juice. It can be observed that after alcoholic fermentation the difference of TDN potential between early and late leaf removal on both sides of the canopy (LREB and LRLB) is less than expected from the grape juice results. This would be explainable by not analysing possible precursor molecules of TDN-precursors in the grape juice, which then are transformed into TDN-precursors during alcoholic fermentation. There are some indications that TDN can be formed from different precursors [5,4], which would fit into the results from the current study. Furthermore, the yeast strain has been shown to impact TDN potential of wines. All wines fermented with yeast strain A showed higher TDN potential than those fermented with yeast strain B. It can be assumed that yeast strains have different enzymatic glycosidase activity during fermentation [14] and therefore can more effectively liberate the aglycons from glycosidical precursors.

4. Conclusion

The results of the study demonstrate the impact of both, grape cluster leaf removal and yeast strain selection on TDN potential in Riesling wines. Therefore these two factors are considered to be effective tools for the management of TDN potential and therefore important for the aroma development of Riesling wines during bottle aging.

References

[1] G. Jones, M. White, O. Cooper, K. Storchmann, Climatic Change **73**, 319-343 (2005)
[2] H. Schultz, Australian Journal of Grape and Wine Research **6**, 2-12 (2000)
[3] G. Britton, *Functions of Carotenoid Metabolites and Breakdown Products*, in *Carotenoids*, G. Britton, S. Liaaen-Jensen, and H. Pfander, Editors. 2008, Birkhäuser Basel. p. 309-324.
[4] D. Waldmann, P. Winterhalter, Vitis **31**, 169-174 (1992)
[5] G. Versini, A. Rapp, J. Marais, F. Mattivi, M. Spraul, Vitis **35**, 15-21 (1996)
[6] M.A. Daniel, D.L. Capone, M.A. Sefton, G.M. Elsey, Australian Journal of Grape and Wine Research **15**, 93-96 (2009)
[7] J. Marais, C.J. van Wijk, A. Rapp, South African Journal of Enology and Viticulture **13**, 23-32 (1992)

[8] J. Marais, G. Versini, C.J. van Wijk, A. Rapp, South African Journal of Enology and Viticulture **13**, 71-77 (1992)
[9] M.T. Kwasniewski, J.E. Vanden Heuvel, B.S. Pan, G.L. Sacks, Journal of Agricultural and Food Chemistry **58**, 6841-6849 (2010)
[10] A. Linsenmeier, O. Löhnertz, South African Journal of Enology and Viticulture **28**, 17-24 (2007)
[11] W.R. Sponholz, T. Hühn, Vitic. Enol. Sci. **52**, 103-108 (1997)
[12] A. Schüttler, M. Friedel, R. Jung, D. Rauhut, P. Darriet, Food Research International **69**, 26-37 (2015)
[13] S.M. Gerdes, P. Winterhalter, E. Ebeler Susan, *Effect of Sunlight Exposure on Norisoprenoid Formation in White Riesling Grapes*, in *Carotenoid-Derived Aroma Compounds*2001, American Chemical Society. p. 262-272.
[14] M. Grossmann, A. Rapp, W. Rieth, Deutsche Lebensmittelrundschau **83**, 7-12 (1987)