XIIIth International Terroir Congress
17–18 November 2020
Virtual Congress | Adelaide, Australia

TERROIR EFFECTS ON WINE AROMATIC METABOLOMICS IN THE EASTERN FOOT OF HELAN MOUNTAIN, NINGXIA, CHINA

Zhanwu Dai[1], Yangfu Kuang[1], Xuenan Yao[1], Huiqing Bai[1], Shaohua Li[1], Benhong Wu[1]*

[1]Beijing Key Laboratory of Grape Science and Enology and Key Laboratory of Plant Resources, Institute of Botany, the Chinese Academy of Sciences, Beijing, 100093, China

*Corresponding author: bhwu@ibcas.ac.cn

Abstract

Aim: The eastern foot of Helan Mountain, Ningxia, China is one of the most important wine production regions in China and grape cultivation has spread in several sub-regions with different soils and cultivars. Large diversity in wine aromas have been observed at Ningxia region but which terroir factors drive those diversity in aromas remain to uncover. This study aims to investigate the impacts of grape varieties and soil chemical properties on wine aromas at Ningxia, in order to characterize the aromatic typicality of Ningxia wines and provide foundation for developing a 'Protected Designation of Origin' system.

Methods and Results: Twenty-six representative wineries from 5 sub-regions of Ningxia were selected, and their vineyard soils were analysed at 20, 40, and 60 cm. Soil electric conductivity, organic carbon, available N, P, K, and total N, P, K, Na, Mg, Ca were quantified. Forty wines from those wineries made from cvs Cabernet Sauvignon, Cabernet Franc, Merlot, etc were also sampled, and their aroma profiles were analysed with GC-MS. Wine aromas showed large diversity, and principal component analysis showed that the key discrimination factor was the variety. Wines from Cabernet Sauvignon, Cabernet Franc, and Merlot exhibited distinct aroma profile, while vineyard location only had minor discrimination contribution. Further analysis for each variety revealed that the wines from Cabernet Sauvignon had quite distinct aromas from different vineyard locations. Soil chemical properties showed clear differences between regions, particularly the quantity of total N, K, and Mg. Correlation network analysis further identified strong and interesting linkages between specific aroma compounds and soil chemical properties.

Conclusions: Our study found both wine aroma and soil chemical properties showing large diversity at Ningxia region. Grape variety plays a key role in determining wine aroma, while vineyard location with different soils can finely tune wine aroma for a given variety.

Significance and Impact of the Study: Our results established the interaction between soil properties and genotypes on wine aromas. It highlights the importance to consider the matching between grape variety and soil type for designing future geographic regulation of wine production in Ningxia.

Keywords: Terroir, soil properties, wine aromas, Helan, Ningxia

Introduction

Wine quality and typicality is essential for a wine region to gain its reputation in the market and attract consumers, therefore being the foundation for assuring a long-term development of the wine industry. Wine quality and typicality is largely determined by wine aromas, which are shaped by a large diversity of biochemical volatile compounds (Gonzalez-Barreiro *et al.,* 2015; Ilc *et al.,* 2016). Many factors can influence wine aromas, such as the cultivar, climate, soil, viticulture managements, as well as the wine making processes, which together form the notation of 'terroir' in viticulture (Clingelleffer, 2014; Costea *et al.,* 2019; Pons *et al.,* 2017; Seguin, 1986; Swiegers *et al.,* 2005; van Leeuwen and Seguin, 2006).

Wine industry is in booming in China during the past decades and has become the 10th biggest wine producing country in the world (OIV, 2019). Wine grape growers and wine makers are learning to define their unique wine quality and typicality with adaptation strategies in mind by choosing suitable cultivars for a given growing regions. Jiang and co-authors (2013) compared the aromas of wines from 3 wine producing regions of China, with each about 500-800 km away and distinct altitude, temperature and rainfall. They identified some 'terroir' specific aromas for Cabernet Sauvignon and Merlot wines, which are the two dominant wine grape cultivars. Zhao *et al.* (2017) studied the key aroma compounds in Syrah wine, and found that the fatty acid ethyl esters, acetate esters, and β-damascenone are vital for aroma typicality. However, the authors only compared wine from different regions with very large geographic distances, lacking detailed analysis of terroir elements that may play key roles causing the differences in aromas. This study aims to investigate the diversities in wine aromas and soil properties for the eastern foot of Helan Mountain, Ningxia, which is one the biggest wine producing regions in China.

Materials and Methods

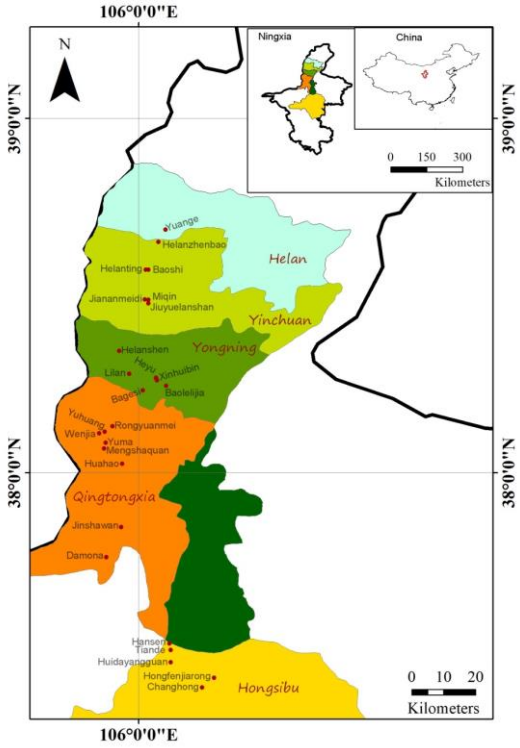

Figure 1: Wineries investigated for both soil and wine aroma analysis at Helan Mountain, Ningxia. Different departments were indicated with different colours.

Soils were collected at 20, 40, and 60 cm between rows and plants over two growing seasons with 3 replicates for each winery. Soil pH, organic carbon, total N, K, Na, Mg, Ca, and available N, P, K were analysed according to standard methods.

In total, 40 wines from the 26 wineries were collected, including 19 of Cabernet Sauvignon, 5 of Merlot, 6 of Cabernet Gernischet, 3 of Shiraz, 1 of Marselan, 1 of Pinot Noir, 4 blends of Cabernet Sauvignon and Merlot, and

1 blend of Cabernet Sauvignon, Merlot, and Shiraz. Wine samples were collected just before bottling with 3 replicates. Five ml wine was used for volatiles collection with the HS-SPME approach and then analysed with GC-MS.

Results and Discussion

After preliminary exploration, soil chemical properties showed high correlations between the two growing seasons studied (data not shown) and therefore the average of the two seasons were analysed with principle component analysis (Figure 2). The first two principle components explained 55% of the variability. No clear discriminations were observed between soil layers. However, the different sub-regions of the eastern foot of Helan Mountain region were clearly separated, with Yinchuan and Qiongtongxia showing most differences. In fact, those two sub-regions were located at the north and south of the region, respectively. Total K, Na, Mg were the three key elements responsible the discrimination of each sub-region (Figure 2 and Figure 3).

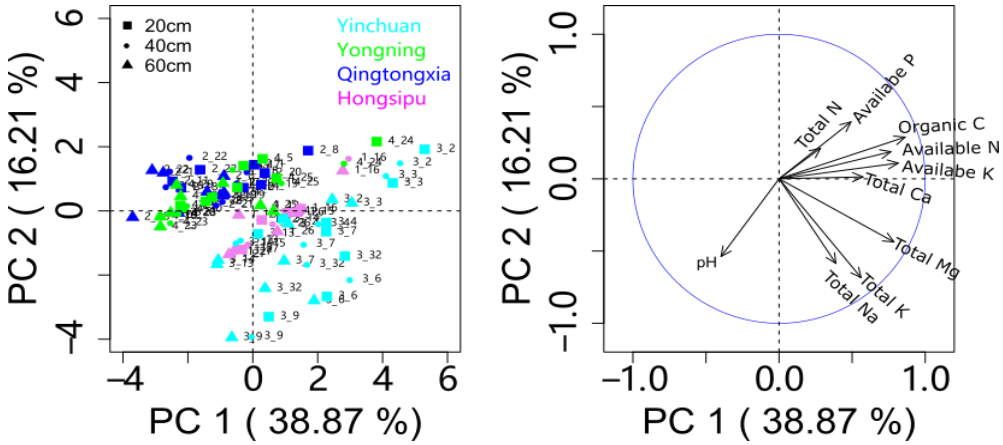

Figure 2: PCA analysis of soil chemical properties.

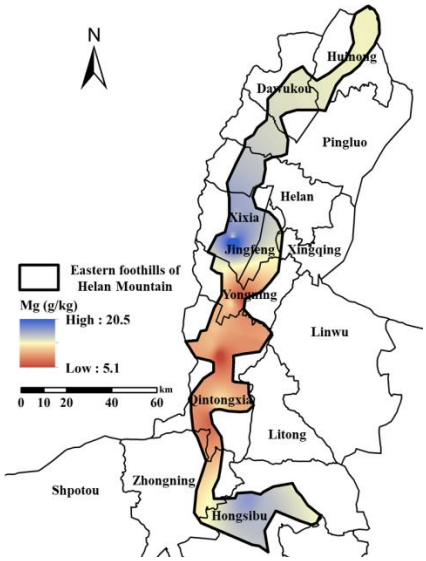

Figure 3: Spatial distribution of total Mg concentration at the eastern foot of Helan Mountain region.

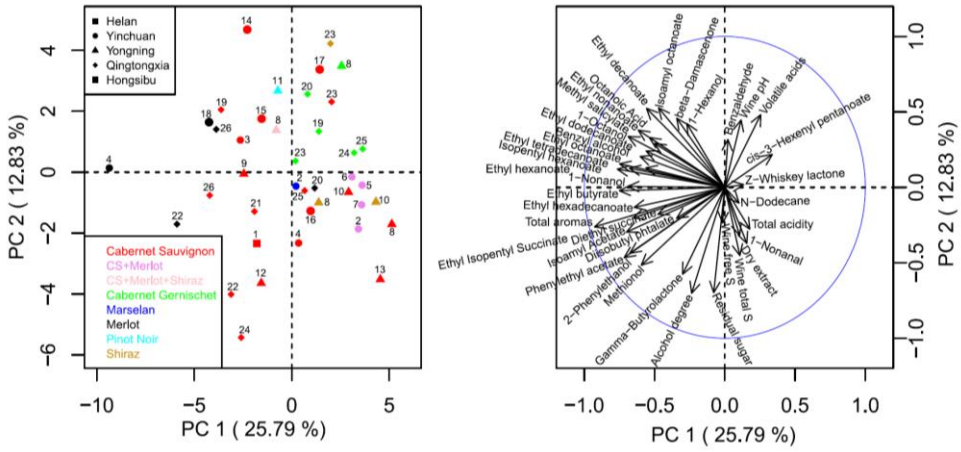

Figure 4: PCA of wine aromas.

The PAC analysis wine aromas revealed that there was no clear discrimination between the sub-regions, even when only considering the 19 wines with Cabernet Sauvignon. However, clear differences between cultivars were observed, e.g. the wines of Cabernet Gernischet and Merlot. It was also clear that wines blended from Cabernet Sauvignon and Merlot had more similar aroma profiles to Cabernet Sauvignon. These results suggested that cultivar is the key determinant of aroma profiles. Further correlation network analysis identified some interesting linkages between soil chemical properties and wine aromas, indicating soil may shape some specific aroma molecules.

Conclusions

Our study found both wine aroma and soil chemical properties showing large diversity at Ningxia region. Grape variety plays a key role in determining wine aroma, while vineyard location with different soils can finely tune wine aroma for a given variety. They highlight the importance to consider the matching between grape variety and soil type for designing future geographic regulation of wine production in Ningxia.

Acknowledgments

This research was supported by funding from the key R&D project (2016BZ06) of Ningxia Hui Autonomous Region, China.

References

Wang, J., Zhang, X., Su, L., Li, H., Zhang, L., Wei, J., 2020. Global warming effects on climate zones for wine grape in Ningxia region, China. Theoretical and Applied Climatology, 140: 1527-1536.

Clingeleffer, P., 2014. Terroir: The application of an old concept in modern viticulture. Encyclopedia of Agriculture and Food Systems, 5:277-288.

Costea, M., Lengyel, E., Stegăruş, D., Rusan, N., Tăuşan, L., 2019. Assessment of climatic conditions as driving factors of wine aromatic compounds: a case study from Central Romania. Theoretical and Applied Climatology, 137(1): 239-254.

González-Barreiro, C., Rial-Otero, R., Cancho-Grande, B., Simal-Gándara, J., 2015. Wine aroma compounds in grapes: a critical review. Critical Reviews in Food Science and Nutrition, 55: 202-218.

Ilc, T., Werck-Reichhart, D., Navrot, N., 2016. Meta-analysis of the core aroma components of grape and wine aroma. Frontiers in Plant Science, 7: 1472-1472.

Jiang, B., Xi, Z., Luo, M., Zhang, Z., 2013. Comparison on aroma compounds in Cabernet Sauvignon and Merlot wines from four wine grape-growing regions in China. Food Research International, 51(2): 482-489.

Pons, A., Allamy, L., Schüttler, A., Rauhut, D., Thibon, C., Darriet, P., 2017. What is the expected impact of climate change on wine aroma compounds and their precursors in grape? OENO One, 51(2): 141-146.

Seguin, G., 1986. Terroirs' and pedology of vinegrowing. Experientia, 42: 861-873.

Swiegers, J., Bartowsky, E., Henschke, P., Pretorius, L., 2005. Yeast and bacterial modulation of wine aroma and flavour. Australian Journal of Grape and Wine Research, 11: 139-173.

van Leeuwen, C., Seguin, G., 2006. The concept of terroir in viticulture. Journal of Wine Research, 17(1): 1-10.

Zhao, P., Gao, J., Qian, M., Li, H., 2017. Characterization of the key aroma compounds in Chinese Syrah wine by gas chromatography-olfactometry-mass spectrometry and aroma reconstitution studies. Molecules, 22(7): 1045.