

A fine wine speaks of its origins. It is a product of a specific place and time. Terroir is the term used to describe this relationship. In the narrowest sense, terroir is concerned with geography and climate. It can only be expressed when vine matches environment. The selected grape variety must reach full ripeness as late as possible in the season. Slow ripening of the berries maximizes aromatic expression in the wine.

by Anna Mouton

# THE SCIENCE



Broader definitions of terroir acknowledge the role of man. Some claim that viticultural and enological techniques dominate the character of a wine. To them, terroir is a marketing trick. Others argue that a skilled winemaker is one who allows a wine to express its unique personality.

The debate has important implications. Terroir is enshrined in systems such as the French Appellation d'Origine Contrôlée. Several hundred French wines qualify for

this certification. Countries as far apart as Australia and Chile have also embraced wine appellation. The purpose is to protect the name and reputation of the product so that it can command a better price. Critics point out that wineries have an economic interest in promoting terroir.

So, is terroir for real? Or is it no more than an excuse for protectionism? This article looks toward science for answers.

## THE SNIFF TEST

Francesco Foroni and colleagues put the concept of terroir to the sniff test. In a study published in *Food Quality and Preference*, volunteers discriminated between pairs of wines based on smell. The participants did not see or taste the wine. It was administered by olfactometer. An olfactometer is a device that directs a controlled dose of wine vapor to the nasal cavity. Some of the volunteers were wine professionals and others were novices.

The wines in question came from the Berici and Euganei hills of Italy. Wines represented different vineyards and grape varieties. Participants smelled a pair of samples and had to decide whether they were different or the same. Each person completed 96 such trials. The article doesn't mention whether they could drink any of the wine after their ordeal.

The best results were for wines that differed in both terroir and grape variety.

Wine professionals and novices were correct in about 70 percent of these trials. They were less successful when wines had the same terroir or were of the same grape variety. Participants could distinguish terroir in some wines made from the same grape variety. They could not tell grape varieties apart when grown in the same terroir.

The researchers conclude that terroir produces subtle changes in olfactory signatures of wines.

## KIWI SHOELACES AND CABERNET SAUVIGNON

A team of researchers led by Anthony Robinson looked into Australian Cabernet Sauvignons. The wines in this study were all Cabernet Sauvignon of the same vintage. They represented 30 vineyards from 10 Australian geographical indications. Geographical indications are the registered wine growing regions of Australia.

The scientists profiled the wines using detailed chemistry. This included HS-SPME GCxGC-TOFS volatile compound analysis. Think of it as a robotic nose with exquisite sensitivity. The analysis constructs a detailed picture of all the odor compounds in the wine.

In addition, a panel of 18 tasters evaluated the wines against taste and aroma standards. The standards included familiar aromas such as oak, floral and earthy. The table

## WHAT DO WE LEARN FROM SAUVIGNON BLANC?

Grapes contain precursors for some of the most important aroma compounds in wine.

These precursors are odorless. They become fragrant due to chemical changes during the fermentation and aging processes.

affect grape maturity or yield. It did affect levels of malic acid and some sulfur precursors in the berries. This was because the vines respond to varying soil nitrogen by changes in gene activity.

This study demonstrates a direct link between soil composition and wine character. The vines adapted their gene expression in response to soil conditions. This led to changes in aromatic precursors in the berries, affecting the odors of the wine.

# OF TERROIR

of recipes for aroma standards in the paper makes entertaining reading. You can find it in *The American Journal of Enology and Viticulture*. The leather standard is an inch of Kiwi leather shoelace, cut into small squares, added to 50 ml of wine.

Both sensory attributes and chemical composition of wines from different regions were distinctive. The differences were greater for geographical indications that are further apart. Frankland River, in Western Australia, was the most idiosyncratic.

This study showed that wines from different places have unique chemical fingerprints. Wine lovers experience this as aroma and taste.

Leather, it turned out, was not significantly different between the wines tested.

Volatile thiols are an important group of aromatics in Sauvignon Blanc. They are not present in the berries and musts. The thiols form during fermentation, from sulfur compounds in the grapes. Thiols contribute the smell of boxwood, grapefruit and passion fruit to wine.

The concentration of sulfur precursors in berries depends on environmental factors. Pierre Helwi and colleagues investigated what drives the formation of these precursors. Their experimental plots were in Bordeaux and the Sancerre area of France. All viticultural practices were the same for the different experimental plots.

The researchers found that vines contained more nitrogen when soil nitrogen was higher. This was not related to increased vine vigor. Extra nitrogen did not significantly

## NATURE AND NATURE

Grape varieties differ in their gene plasticity. They will react to changes in environment in different ways.

Approximately 18 percent of the genes in vines can respond to the environment. Climate has the strongest effect on gene expression. That is why berry composition fluctuates from one year to the next.

Grapes contain a range of



complex molecules made by the vine.

These metabolites are the basis for many of the aromas, flavors and colors found in wine. Metabolomics is the study of all the chemicals resulting from cellular processes. It can resolve the relationship between berry composition, gene expression and the environment.



Andrea Anesi and fellow researchers applied metabolomics to Corvina grapes. The vines were of a single clone, grown in seven different vineyards in three regions of Italy. The project ran for three years.

The scientists found that vintage was the strongest predictor of berry composition. Nonetheless, grapes from different terroirs did show distinct metabolic profiles. Some of the factors that affected metabolism were lime, clay and potassium in the soil. Vines respond to the environment by small changes in many genes. The cumulative effect is an expression of terroir.

A similar result came from work by Giuliano Pereira in Bordeaux. His group analyzed Merlot, Cabernet Sauvignon and Cabernet Franc from three different soil types. Wines from different soil types had distinct chemical profiles. This effect was strongest in a hot, dry year, most likely due to differing water reserves in the soils.

The expression of terroir depends on an interplay of climate, aspect, soil and the vine. The complexity of these relationships is one reason why terroir is hard to pin down.

### IN MINT CONDITION

Minty or eucalyptus aromas in wine result from a compound called 1,8-cineole. Eucalyptus aromas are typical of wines from vineyards grown close to eucalyptus trees. Of course, gum trees have spread from Australia to much of the rest of the world. Many do well in conditions that favor vines.

A study proved that the association between aroma and tree was real. Wine made from grapes grown close to gum trees

had the highest levels of 1,8-cineole. Closer examination revealed that the primary source was eucalyptus leaves. The leaves contaminated the harvest. Since this finding, winemakers are able to adjust the 1,8-cineole levels in their product. They control the expression of this aspect of terroir.

Rotundone is another aromatic in wine. It lends peppery notes to Shiraz. There are large fluctuations in rotundone levels between vintages and vineyards. Researchers sampled berries from 177 vines spread across a single 6 hectare vineyard. They measured rotundone and found a spatial pattern in the levels. The scientists concluded that soil structure is one driver of rotundone concentrations.

### SPIRIT OF PLACE

Science provides clear evidence of the link between wine and environment. The relationship is strongest when the

vine matches the climate. Early ripening of grapes in warm climates will result in bland wines. Technology can compensate for a lack of aroma, but will not yield terroir expression.

In a paper published in the *Journal of Wine Research*, Cornelis van Leeuwen and Gerard Seguin consider history to be as much a part of terroir as climate. History explains why vineyards are where they are and why they succeed or fail.

History is the story of people and places. In the past, nothing linked people to the land more than food. Terroir in the sense of locality was central to human experience. Globalization and industrial food production threatens this bond. That is why we need terroir and why it concerns more than quality or price.

Terroir is about opening a bottle of wine and connecting to the land. In doing so, the wine lover rediscovers something about being human. ●

## About The Author

Anna Mouton was born in Stellenbosch, in the heart of the Cape Wine-lands. She now lives amongst the Overberg vineyards of the Western Cape of South Africa. Before becoming a freelance science writer, she practiced as a veterinarian.