

Characterization of Mountain and High-Hill Viticultural Areas in the Mandrolisai District in Sardinia

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Introduction

Viticulture in mountain and high-hill areas represents a complex system strongly influenced by pedoclimatic conditions and traditional farming practices. In Sardinia, the Mandrolisai district is a representative example of so-called “heroic viticulture”, characterized by high environmental heterogeneity and a strong linkage between territory, agricultural practices, and cultural identity. The Mandrolisai DOC appellation is based on a traditional blend of Cannonau, Monica, and Bovale Sardo grape varieties, cultivated under different altitudinal conditions that significantly affect yield performance and grape quality. In this context, viticultural zoning is a key tool to investigate the relationships between environmental factors, vineyard management and production quality, contributing to the enhancement of local terroirs.

Material and methods

The study focused on two viticultural areas in central Sardinia:

- **Meana Sardo** (500–700 meters a.s.l.), representing mountain viticulture;
- **Ortueroi** (300–500 meters a.s.l.), representing high-hill viticulture.

The following aspects were analyzed:

vineyard management systems and their spatial distribution
 main suitability factors:

- altitude
- exposure
- slope
- soil characteristics
- yield performance
- main qualitative parameters of musts

All data were georeferenced and processed using GIS tools, allowing the creation of thematic maps describing spatial variability both within and between the study areas.

Table 1. Vineyard area and altitude in Meana Sardo and Ortueroi

ID Vineyard	Trellis system	Area (ha)	Esposition	Altitude (m)
M_1	VSP	0.64	E	720
M_2	Gobelet	1.12	S	613
M_3	VSP	0.59	NE	674
M_4	VSP	0.53	SO	719
M_5	Gobelet	0.34	SW	517
R_1	Gobelet	0.75	SE	450
R_2	VSP	1.26	NW	470
R_3	VSP	0.54	N-NW	505

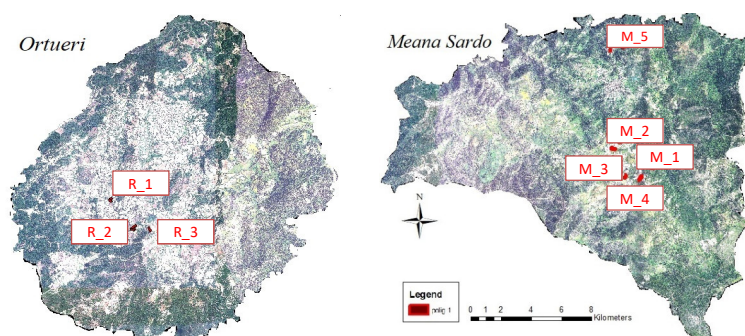


Figure 1. Location of the study areas and representative vineyards within the municipalities of Ortueroi and Meana Sardo.

Results and Discussion

The results highlight a pronounced spatial variability both between the two study areas and within each municipality.

Phenological dynamics were strongly influenced by altitude and thermal amplitude (data not shown). Yield performance varied according to pedoclimatic conditions and vineyard management practices, reflecting the adaptability of the production systems to local environments. Although significant differences in must quality parameters were observed when data were aggregated by vineyard (Figure 2), spatial analysis further revealed that vineyards within the same municipality may exhibit markedly different productive and qualitative behaviors, confirming the high degree of terroir heterogeneity characterizing the Mandrolisai area.

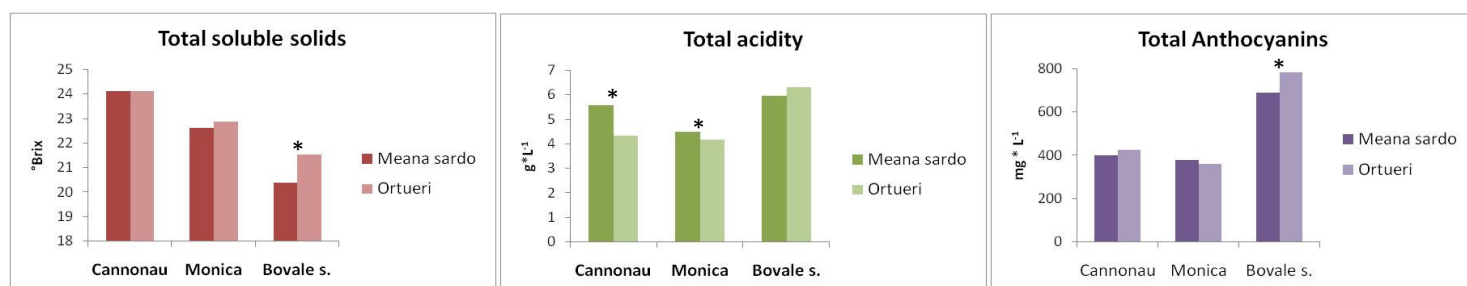


Figure 2. Mean values of sugars, total acidity, and total anthocyanins at harvest in five vineyards in Meana Sardo and three in Ortueroi, separated by variety. * indicate significant differences ($p < 0.05$) between the two municipalities.

Conclusion

The Mandrolisai area exhibits a high degree of viticultural heterogeneity driven by environmental factors such as altitude, soil, and exposure, which significantly affect both yield and grape quality. This spatial variability, observed both between and within the study areas, represents a key element for the development of effective zoning strategies and for enhancing the oenological identity of the territory. Understanding these interactions is essential for supporting sustainable viticulture in mountain and high-hill environments.