

Comparative Phenotypic and Ampelographic Evaluation of the Autochthonous Georgian Grapevine (*Vitis vinifera* L.) Varieties 'Orbeluri' and 'Orbeluri' versus the Introduced Variety 'Merlot'

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Abstract

This comprehensive scientific study investigates the phenotypic, ampelographic and enological differentiation of the indigenous Western Georgian red grapevine (*Vitis vinifera* L.) varieties 'Orbeluri' (also known locally as Orbeluri Ojaleshi or Lechkhumis Ojaleshi) and 'Ojaleshi' in comparison with the introduced French variety 'Merlot'. In certain international databases and taxonomic literature these distinct Georgian cultivars have occasionally been misclassified or listed as synonyms of Merlot. Local terminology further confuses Orbeluri (native to Lechkhumi) with Ojaleshi (native to Samegrelo). Using 41 standard OIV descriptors together with micro-vinification trials conducted in 2023–2024, the study demonstrates that Orbeluri and Merlot share 28 descriptors yet differ significantly in 13 key morphological and enological traits. Orbeluri and Ojaleshi differ across 16 morphological descriptors, confirming their botanical independence. Enological analysis showed that Orbeluri produces a balanced ruby-red dry wine (12.3 % alcohol, 5.7 g L⁻¹ titratable acidity), Ojaleshi a high-acidity cherry-red wine (9.5 % alcohol, 8.7 g L⁻¹ titratable acidity), and Merlot a full-bodied wine (13.2 % alcohol). These results refute the erroneous synonymy and underline the enological value of the Georgian autochthonous varieties.

Key words: ampelography, OIV descriptors, comparative varietal analysis, Georgian Varieties

1. Introduction

Georgia is widely recognized as one of the principal centers of origin of the grapevine and of winemaking. Chemical analysis of pottery residues dating to roughly 6,000–5,800 BCE in Georgia's South Caucasus region has identified traces of *Vitis vinifera*, the Eurasian grapevine from which nearly all wine produced today derives (Riaz, 2018; McGovern et al., 2017; Y. Dong et al., 2023). Georgia is likewise recognized as the homeland of the wild ancestor of *Vitis vinifera*, *V. vinifera* subsp. *silvestris* (Maghradze et al.,

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2016a, Maghardze, Mdinaradze, 2012;). Georgia ranks 18th worldwide in wine production. At the regional level, the country consists of 10 main wine-growing regions and 30 Protected Designations of Origin (PDOs) (Figure 1).



Figure 1. Map of winemaking. Source. the National Wine Agency of Georgia, 2026.

For Georgia, the vine and wine represent not merely an economic foundation but one of the central pillars of national identity (Maghradze, Mekhuzhla et al., 2016).

Georgia is also known for its original Qvevri method of winemaking, which has no direct equivalent elsewhere. In recognition of its cultural significance, UNESCO inscribed the ancient Georgian traditional Qvevri wine-making method on the Representative List of the Intangible Cultural Heritage of Humanity in 2013 (UNESCO, 2013; Chkhartishvili, Maghradze 2023; Kalandia et al, 2024). In addition, Georgian winemaking is distinguished from that of other wine-producing countries by its almost exclusive reliance on indigenous grape varieties rather than international ones (National Wine Agency of Georgia, 2026).

Georgia is furthermore recognized for the remarkable diversity of its autochthonous grape varieties: the country is home to 525 identified grape varieties, and wild vines still grow there today (Ketshoveli, Ramishvili et al, 1960). Despite this diversity, industrial production remains concentrated on two varieties, Saperavi and Rkatsiteli, which account for approximately 57.5% and 33.6% of the annual national grape harvest respectively — together over 90% (National Wine Agency of Georgia, 2026).

According to the National Wine Agency Cadastre (2025), Georgia's total vineyard area spans 48,643 hectares, comprising 23,153 ha of white varieties and 19,667 ha of red varieties. Historical ampelographic

classifications by N. Ketskhoveli, M. Ramishvili, and D. Tabidze (1960) documented 525 indigenous varieties distributed across traditional winemaking regions: Kakheti (89), Kartli (68), Imereti (85), Racha-Lechkhumi (64), Guria (59), Samegrelo (50), Adjara (45), Abkhazia (51), Meskheta (9), and Saingilo (5).

Given the difficult conditions currently facing the Global wine sector - wine consumption in 2025 fell to its lowest level since 1996, continuing a steady downward trend driven in part by falling demand in China and by inflationary pressure on prices (International Organisation of Vine and Wine - OIV, 2026) - particular importance attaches to production diversification through less widespread, terroir-specific local varieties. Such varieties serve multiple functions at once: they diversify the range of available wines, and they enable small wineries to produce high-quality, premium-priced products. It is in this context that the present study assumes particular relevance.

It must nonetheless be emphasized that, in contrast to the major commercial varieties, the cultivation of less widespread varieties is frequently accompanied by inconsistent data regarding varietal identification. Local growers often cultivate rare varieties in settings where names are changed, misapplied, or attached to the wrong variety altogether — a problem that is especially common among red-skinned varieties, which are visually more difficult to distinguish.

A case in point, directly relevant to the present study, is the pair of redskinned west Georgia Varieties Ojaleshi and Orbeluri (Orbeluri Ojaleshi). Georgian wine legislation and research community formally recognizes Ojaleshi and Orbeluri Ojaleshi as two distinct varieties (Ujmajuridze, Mamasakhlisashvili et al, 2018) , yet winemakers in the Lechkhumi region commonly label wine made from Orbeluri Ojaleshi simply as “Ojaleshi,” .

In fact, the two represent genetically and geographically distinct cultivars: Ojaleshi is an autochthonous variety native to the Samegrelo region, while Orbeluri is indigenous to the Lechkhumi viticultural zone (**Figure 2**). Conflating these two taxonomically and ecogeographically distinct varieties — and erroneously equating either with Merlot — undermines both the scientific record and the practical management of Georgia's indigenous grapevine germplasm. In addition, In some publication have in some cases attributed the Ojaleshi variety to Merlot [Troshin et al, 2010).

1.1 Research Relevance

In the context of modern globalization and international agricultural integration, the accurate identification of grapevine cultivars and the resolution of synonym ambiguities have become imperative for safeguarding national genetic resources, carrying substantial scientific and economic weight. Certain international compendia — notably the Vitis International Variety Catalogue (VIVC) — have historically classified the Georgian red grapevine varieties "Orbeluri" (also known as Orbeluri Ojaleshi or Lechkhumi Ojaleshi) and "Ojaleshi" as synonyms of the French variety "Merlot," a designation that is scientifically unsubstantiated.

Georgia — municipalities map with highlighted wine districts



Figure 2. Map of production of Ojaleshi and Orbeluri main regions of Georgia according to the National Wine Agency of Georgia. Ojaleshi – Red color, Orbeluri – Yellow color

Despite this fragmentary body of research literature, no comparative characterization exists that offers a scientifically grounded comparison across the full range of ampelographic, Phenotyping, and enological traits — a gap whose closure would constitute a meaningful scientific contribution to the field.

Resolving this taxonomic ambiguity therefore requires rigorous, standardized ampelographic (morphological), ampelometric, and enological characterization, conducted in strict accordance with the descriptor system established by the International Organisation of Vine and Wine (OIV), to provide definitive cultivar identification by phenotypic features.

1.2 Research Objective

The primary objective of this research was to scientifically establish and validate the phenotypic, ampelographic, and enological differentiation between the autochthonous Georgian varieties Ojaleshi and Orbeluri, and to compare them with the introduced European variety Merlot, using the standardized framework of 41 OIV ampelographic descriptors.

1.3 Research Tasks

1. Systematic overview review of the literature. Critical review and synthesis of historical and contemporary ampelographic and viticultural literature pertaining to the Ojaleshi and Orbeluri varieties, including archival ampelographic descriptions, regional viticultural records, in order to establish the current state of knowledge and identify existing gaps and inconsistencies in varietal identification.

2. Ampelographic characterization. Detailed ampelographic description of the study accessions using the standardized set of the principle 41 OIV descriptors, encompassing qualitative and quantitative traits of the young shoot, mature leaf, bunch, and berry, recorded according to OIV methodology (developmental stage, sampling protocol, and descriptor coding scale) to ensure comparability with international ampelographic databases.
3. Photographic and digital documentation. Systematic photographic and digital recording of diagnostic morphological organs (young shoot tip, mature leaf, bunch, berry) under standardized conditions, to serve as a visual reference archive supporting descriptor scoring, enabling independent verification, and contributing to future varietal identification and germplasm cataloguing efforts.
4. Experimental micro-vinification. Production of experimental wines from each cultivar under controlled, standardized micro-vinification conditions following classical European (Bordeaux-type) red winemaking technology and ensure that observed differences reflect varietal rather than technological factors.
5. Biochemical laboratory analysis. Rigorous biochemical analysis including determination of alcohol content, Brix and titratable acidity, using standard OIV-approved analytical methods, to establish an objective enological profile for each variety.

1.4 Research Objects

The experimental research focused on three red-skinned grapevine (*Vitis vinifera* L.) varieties, selected to represent both the object of taxonomic uncertainty under investigation and an internationally recognized reference standard for comparative purposes:

1. **Orbeluri (syn. Orbeluri Ojaleshi, Orbelis Ojaleshi, Lechkhumis Ojaleshi)** - an autochthonous Georgian variety indigenous to the Lechkhumi micro-region (specifically Tsageri Municipality, village Orbeli). of western Georgia, cultivated traditionally alongside other local varieties of the area, such as Usakhelouri and Tsolikouri . this variety Exhibits medium-to-strong vegetative vigor and high productivity (7.0–8.0 t/ha). Grapes accumulate 18.5–21.3% sugar and 5.5–6.8 g/L titratable acidity. Yields balanced, ruby-red dry wines with pleasant varietal aromas.
2. **Ojaleshi** -Autochthonous to Samegrelo, historically cultivated on living trees (maghlari) in the Tekhuri river valley (e.g., Salkhino estate established by the Dadiani princes and expanded by Achille Murat in the 1880s). Characterized by high acidity (8.5–9.2 g/L), moderate sugar accumulation (20.0–24.0%), and deep pomegranate-red coloration.
3. **Merlot** - An introduced French well known international variety cultivated widely across European Union appellations, characterized by moderate productivity and susceptibility to fungal pathogens, yielding wines rich in red berry fruit notes with 22.0–26.0% sugar at harvest.

3. Research Methodology and Experimental Conditions

3.1 Experimental Sites

Scientific- research center of Agriculture – SRCA Jighaura Research Station: Located in the Shida Kartli plain (Mukhrani-Saguramo sub-zone, Mtskheta Municipality) at an elevation of 595 - 600 m above sea level. The climate is moderately warm with cold winters and hot summers (**Figure 3**).

Orbeli Vineyard: Located in the Lechkhumi region (Tsageri Municipality) in the Lajanuri river gorge at 600 m elevation, characterized by humid temperate conditions and sloping terraced terrain.

University Laboratories: Ampelographic and micro-vinification analyses were executed at Caucasus International University research facilities during the 2023 - 2024 vegetation periods. Harvest dates were set at optimal technological maturity: Merlot on September 16, 2023; Ojaleshi on September 25, 2023; and Orbeluri on October 27, 2023.

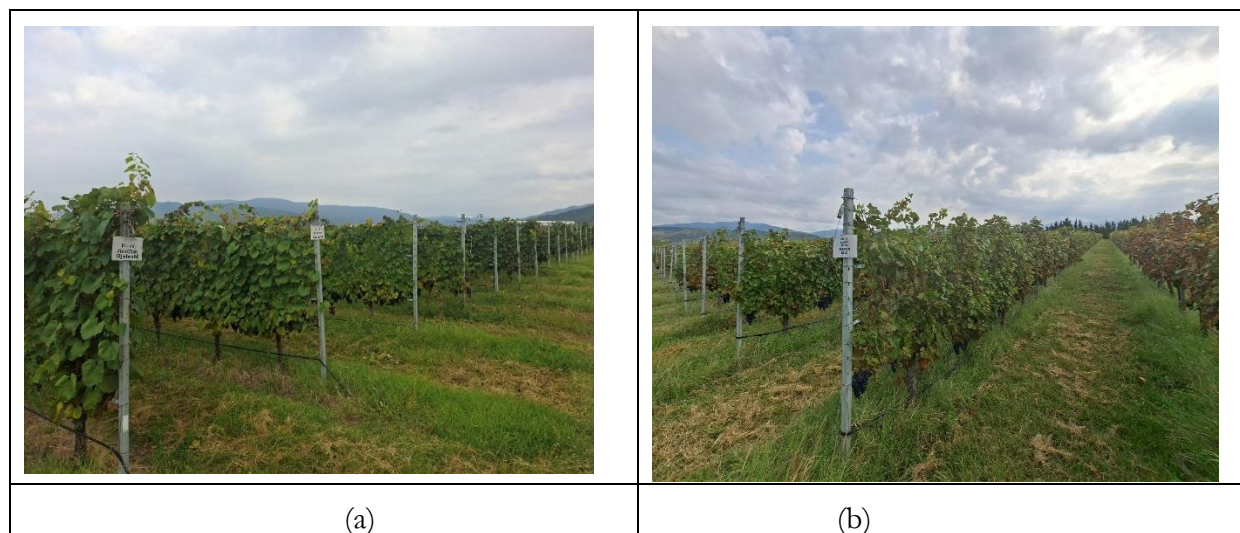


Figure 3. SRCA Jighaura Experimental station grape collection. (a) – Ojaleshi; (b)-Merlot

3.2 Ampelographic and Enological Protocols

Morphological evaluation was conducted in strict accordance with the 41 standard descriptors of the International Organisation of Vine and Wine (OIV), spanning young shoots, unfolding leaves, mature leaves, inflorescences, bunches, and berries. Experimental wines were produced via classical European white/red vinification methodology involving destemming, crushing, sulfur dioxide treatment (35 mg/L), cold settling for 3 days, inoculated alcoholic fermentation using selected yeasts (0.3 g/L) at 17–20°C, systematic racking, and physicochemical testing.

4. Results and Discussion

4.1 Comparative Ampelographic Analysis via OIV Descriptors

Evaluation of the 41 OIV descriptors across ‘Orbeluri’, ‘Ojaleshi’ and ‘Merlot’ showed that the three cultivars share a number of fundamental traits characteristic of *Vitis vinifera* L. (open growing tips, hermaphroditic flowers, cuneiform mature leaf blade, spherical berries, etc.). Nevertheless, clear phenotypic divergence exists (Table 1).

Orbeluri versus Merlot share 28 descriptors but differ significantly in 13 traits, including growing-tip anthocyanin coloration, leaf-blade blistering, petiole-sinus shape, bunch dimensions and must composition.

Orbeluri versus Ojaleshi differ across 16 morphological descriptors, most notably leaf lobation (five-lobed versus three-lobed), young-leaf colour and internode pigmentation, thereby refuting any claim of identity or synonymy.

Merlot versus Ojaleshi differ across 20 morphological and agronomic descriptors.

OIV Code / Descriptor	Orbeluri	Ojaleshi	Merlot
OIV 001 (Growing tip shape)	Open (5)	Open (5)	Open (5)

OIV 003 (Growing tip anthocyanin coloration)	Weak (3)	Absent / Very weak (1)	Medium (5)
OIV 007 (Internode dorsal coloration)	Green (1)	Red (3)	Green (1)
OIV 051 (Young leaf blade upper surface colour)	Green (1)	Copper-red (3)	Green (1)
OIV 067 (Mature leaf blade shape)	Cuneiform (3)	Cuneiform (2)	Cuneiform (3)
OIV 068 (Number of leaf lobes)	Five-lobed (3)	Three-lobed (2)	Five-lobed (3)
OIV 070 (Main veins upper surface anthocyanin)	Absent (1)	Up to 1st bifurcation (3)	Absent (1)
OIV 075 (Leaf blade upper surface blistering)	Weak (3)	Strong (7)	Medium (5)
OIV 080 (Petiole sinus shape)	V-shaped (3)	V-shaped (3)	U-shaped (1)
OIV 094 (Superior lateral sinus depth)	Medium (5)	Absent / Very small (1)	Medium (5)
OIV 202 (Bunch length)	Short (3)	Short (3)	Medium (5)
OIV 208 (Bunch shape)	Conical (2)	Cylindrical-conical (2)	Conical (2)

Table 1. Comparative OIV Descriptors and Physicochemical Parameters of Studied Grapevine Varieties

4.2 Key Ampelographic Distinctions

Orbeluri versus Merlot. Out of 41 descriptors, 28 are shared. The cultivars differ significantly across 13 descriptors, including growing-tip anthocyanin coloration, leaf blistering, petiole-sinus shape, bunch dimensions and must composition.

		
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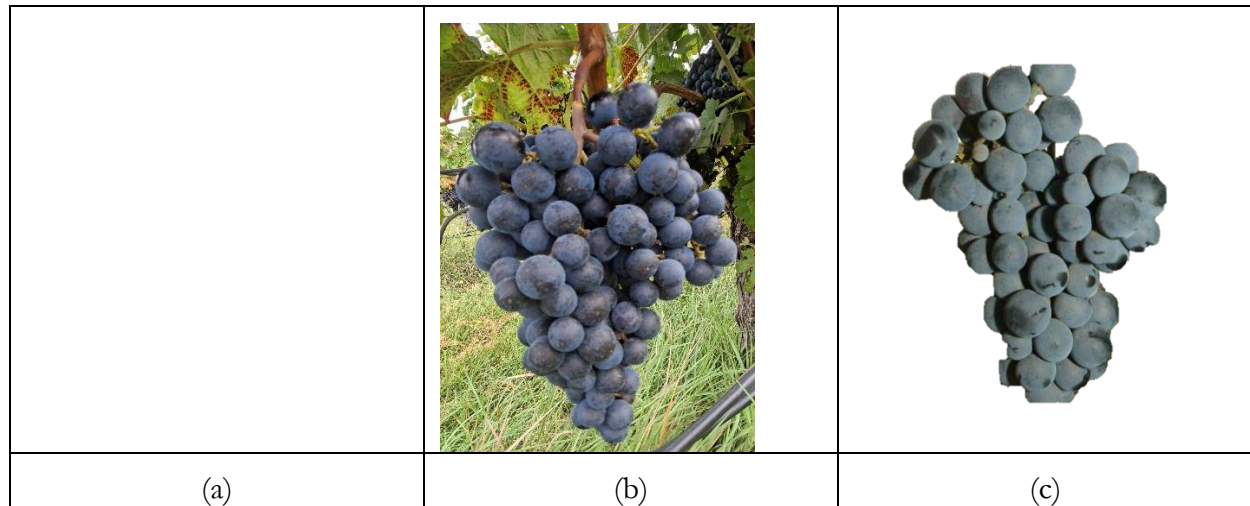


Figure 4. Photo of bunch varieties: (a) Ojaleshi; (b) Merlot; (c) Orbeluri

Orbeluri versus Ojaleshi. The two varieties differ across 16 morphological descriptors. The most diagnostic differences are leaf lobation (Orbeluri five-lobed versus Ojaleshi three-lobed), young-leaf upper-surface colour (green versus copper-red) and internode dorsal pigmentation (green versus red). These differences completely refute claims of identity or synonymy (**Figure 4, Figure 5, Figure 6.**)

Merlot versus Ojaleshi. Differ across 20 distinct morphological and agronomic descriptors.

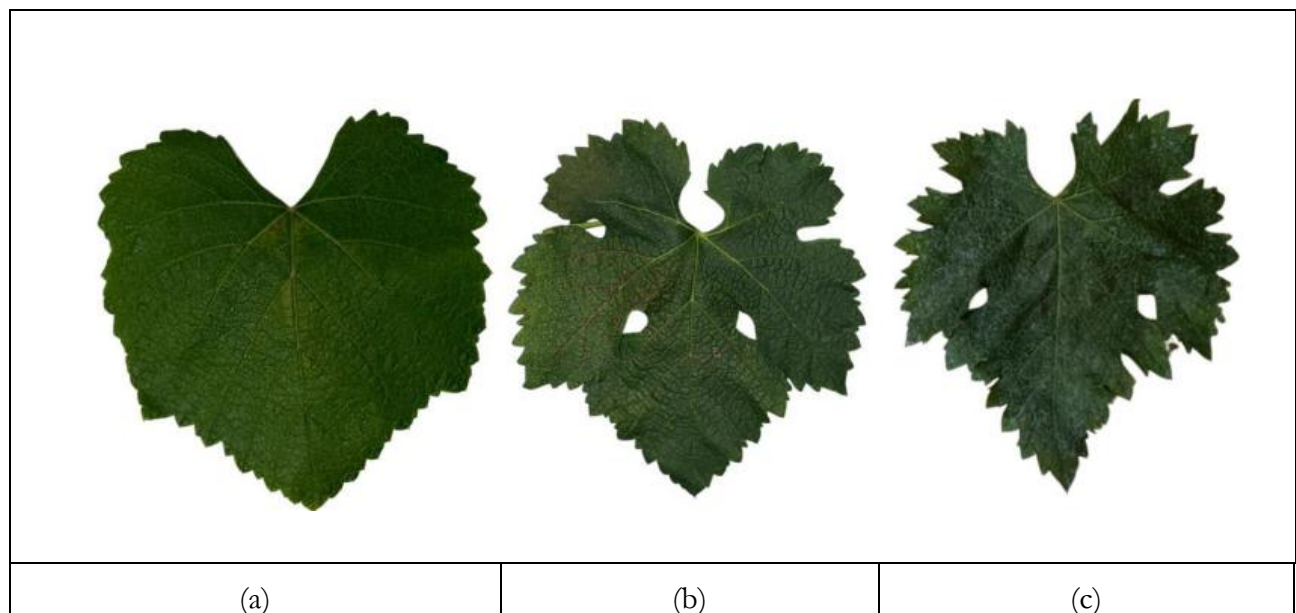
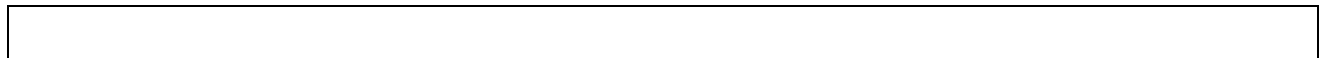


Figure 5. Photo of leaves Shape varieties: (a) Ojaleshi; (b) Merlot; (c) Orbeluri



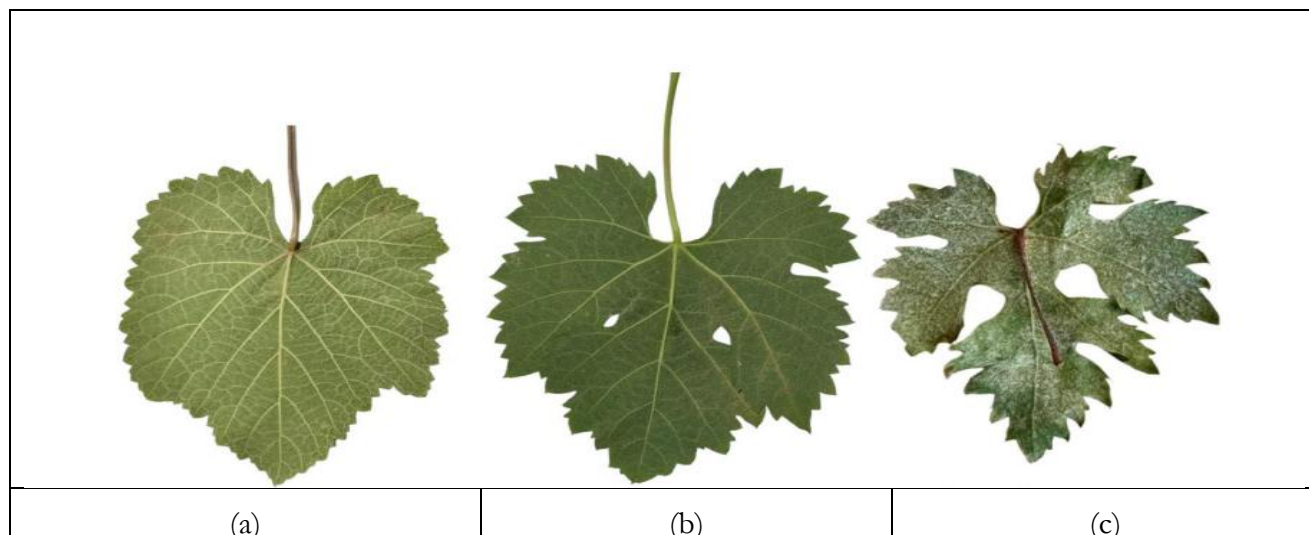


Figure 6. Photos of leaves Shape varieties: (a) Ojaleshi; (b) Merlot; (c) Orbeluri

4.3 Enological and Sensory Evaluation

Orbeluri wine. Exhibits a brilliant ruby-red coloration, clean varietal aroma profile with pleasant red-berry notes, moderate body, 12.3 % alcohol, 5.7 g L⁻¹ titratable acidity and balanced structure.

Ojaleshi wine. Characterised by a vibrant cherry-red hue, high natural acidity (8.7 g L⁻¹), delicate red-fruit aromas, light-to-medium body and refreshing palate vivacity (9.5 % alcohol).

Merlot wine. Displays deep coloration, intensive berry aromatics, full body, 13.2 % alcohol and harmonious velvety tannins.(Figure 7)

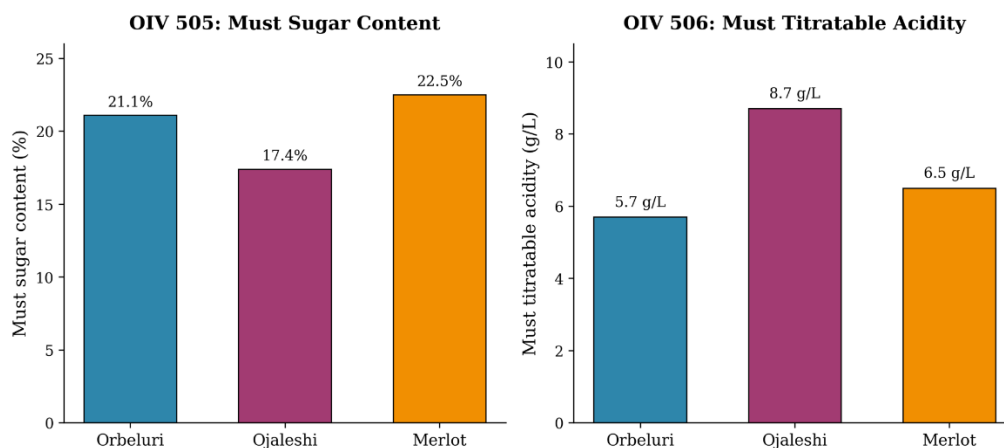


Figure 7. Diagrams of OIV 505 and OIV 506 descriptors for studied varieties

Based on the comprehensive ampelographic characterization (including OIV-coded morphological descriptors of young shoots, mature leaves, and bunches), phenotypical observations (leaf shape, lobation, pubescence density on the abaxial surface, and young-shoot anthocyanin coloration), and complementary biochemical parameters (must soluble solids content expressed as °Brix and titratable acidity), a comparative multi-descriptor matrix was constructed. This integrative dataset enables rigorous taxonomic discrimination among the studied grapevine cultivars (Orbeluri, Ojaleshi, and Merlot), quantifies the degree of morphological divergence, and provides a robust foundation for assessing

potential synonymy claims, enological suitability, and regional adaptation. Based on this was prepared comparative rataser of studied varieties: **(Table 2)**.

Descriptor	Orbeluri	Ojaleshi	Merlot
Origin	Georgia (western/Lechkhumi–Racha area; village Orbeli, Tsageri district); classified in Western European eco-geographic group; sometimes confused with Ojaleshi but distinct	Georgia (western, Samegrelo/Mingrelia; mountainous areas along Tskhenis-Tskali and related rivers); ancient indigenous variety	Bordeaux (France); parentage Cabernet Franc × Magdeleine Noire des Charentes
Color (berry/skin)	Dark blue to almost black	Dark blue / deep purple / black	Dark blue-black / blue-black
Ripening period	Medium-late (~160 days from budburst to full maturity; sum of active temperatures ~2900 °C in native area)	Late (vegetation period ~245 days; full maturity mid-November in mountainous Samegrelo; harvest often late November–early December)	Medium (2nd epoch; typically ~2 weeks earlier than Cabernet Sauvignon; ~2.5 weeks after Chasselas)
Leaf shape	Medium, rounded (sometimes slightly oval); 3-lobed (rarely 5-lobed); medium to weakly dissected; cuneiform (OIV 067: 3); reticulate-rugose	Medium, roundish/nearly entire (often described as 3-lobed); cuneiform (OIV 067: 2); petiole sinus large V-shaped	Medium to large, cuneiform/pentagonal; typically 5-lobed (sometimes 7); cuneiform (OIV 067: 3); dark green, strongly blistered
Leaf pubescence on back (lower side)	Weak (weakly arachnoid / weakly formed long white tangled hairs)	Thick / dense hairs (lower side covered in thick/dense pubescence)	Low to medium density of prostrate hairs (between main veins); generally sparse to medium
Young shoot color	Growing tip anthocyanin weak (OIV 003: 3); internode dorsal green (OIV 007: 1); young leaf upper surface green (OIV 051: 1)	Growing tip anthocyanin absent/very weak (OIV 003: 1); internode dorsal red (OIV 007: 3); young leaf upper surface copper-red (OIV 051: 3); tip often with dense white-violaceous hairs	Growing tip anthocyanin medium (OIV 003: 5); internode dorsal green (OIV 007: 1); young leaf upper surface green (OIV 051: 1); tip with dense prostrate hairs

Brix content (typical at harvest / must)	moderate sugars (~21–23° Brix range under typical conditions)	High: 23–24% sugar (or ~23–24° Brix) at full maturity	Typically 22–25° Brix (optimal often 23–24° Brix for balanced wines; can reach higher in warm climates)
Acid content (titratable acidity)	Moderate; wine ~5.7 g/L	High: ~8.5–9% (or ~8.5–9 g/L) at harvest; wine often ~8.7 g/L	Moderate to relatively low: typically 4.5–6.5 g/L (sometimes 5–7 g/L); lower than many red varieties
Regional distribution	Mainly Georgia (Racha-Lechkhumi / western Georgia); limited plantings elsewhere (low commercial acreage)	Primarily western Georgia (Samegrelo, also Lechkhumi, parts of Guria/Adjara); traditional maghlari (tree-trained) system in mountains	Worldwide (one of the most planted red varieties);

Table 2. Comparative OIV Descriptors and Physicochemical Parameters of Studied Grapevine Varieties Orbeluri, Ojaleshi and Merlot

5. Conclusions

The comprehensive ampelographic and enological evaluation conducted in this study provides clear evidence that varieties - Orbeluri, Ojaleshi, and Merlot constitute genetically and morphologically distinct cultivars within *Vitis vinifera* L., despite their shared species classification.

It was established the synonym designation applied to the Georgian varieties Orbeluri and Ojaleshi in some resources and perpetuated in parts of the associated literature, is not supported by the present morphological evidence: divergence was observed across 13 to 20 primary OIV descriptors, a magnitude of differentiation inconsistent with true synonymy and indicative of a historical misclassification requiring formal correction.

According of research the practice of conflating Orbeluri (autochthonous to Lechkhumi) with Ojaleshi (autochthonous to Samegrelo) on the basis of lexical similarity is not supported by the ampelographic and enological data: the two varieties differ consistently in leaf lobation (five-lobed versus three-lobed), shoot pigmentation patterns, and key ripening and enological parameters, confirming their status as distinguished cultivars with distinct regional origins.

It is important note, that both local varieties – Orbeluri and Orbeluri Ojaleshi demonstrate substantial enological potential, underscoring their significance as genetic resources for the production of high quality, terroir-specific Georgian red wines. These findings support the revision of existing catalogue entries and highlight the broader value of detailed ampelographic characterization for the conservation and accurate documentation of Georgia's autochthonous grapevine germplasm.

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Author Contributions

Conceptualization, I.M.; methodology, I.M.; data collection and investigation, N.A.; formal analysis, N.A.; resources, N.A.; writing—original draft preparation, N.A.; writing—review and editing, I.M. and N.A.; visualization, N.A.; supervision, I.M.; and project administration, I.M. All authors have read and agreed to the published version of the manuscript.

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Conflict of Interest

The authors declare no conflict of interest.

Data Availability Statement

The data presented in this study are contained within the article.