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Ampelographic Characterization of the A'asmi Cultivar of Yemeni Grape (*Vitis vinifera* L.)

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Abstract

The study was conducted to characterize the morphological traits of A'asmi Cultivar of Yemeni grape (*Vitis vinifera* L.) in the Bani Hashish district during the 2021 and 2022 seasons, based on OIV, UPOV, and IPGRI standards. The aim was to establish a database documenting the morphological characteristics and certain chemical properties of the Cultivar, to support breeding programs, preserve genetic diversity, and enhance agricultural productivity amid environmental challenges. The study involved 10 fruiting vines from a farm in the village of Bayt al-Nukhif, Wadi al-Sir, where 106 traits were measured, encompassing young and mature shoots, leaves, flowers, clusters, berries, and seeds, in addition to the evaluation of selected chemical properties such as soluble sugars, acidity, pH, and vitamin C using standardized methodologies. The results revealed a notable coherence in the morphological traits of the Cultivar. The young shoot was characterized by an open and fully developed apex before the node, indicating vigorous vegetative growth and an ability to adapt to warm seasons, while a weak expression of anthocyanins on the pubescence suggested a potential genetic limitation in expressing this pigment and its effect on the plant's response to environmental stresses. The mature shoot exhibited a nearly vertical growth pattern with a balanced color distribution on its sides and a reduced pubescence density, which may improve ventilation and reduce the risk of fungal diseases. The leaves maintained stability in terms of shape, size, and number of lobes, with a balanced pigment distribution that reflects an equilibrium between genetic and environmental factors to enhance photosynthetic efficiency and nutrient transport. At the cluster and berry level, productive traits were manifested through a loose distribution of berries and a long conical shape, along with an increase in berry number and stability in dimensional ratios and weight. The seeds showed dimensional stability with variations in biomass accumulation, reflecting the influence of environmental factors. Furthermore, the hermaphroditic floral structure contributed to both self- and cross-pollination, thereby enhancing genetic diversity. Overall, the study comprehensively documented and evaluated the morphological and chemical performance of the A'asmi Cultivar under the circumstances of the region.

Article Info

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Grapes, Yemeni grape, Ampelography, A'asmi cultivar, Genetic diversity.

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1. INTRODUCTION

Grapes (*Vitis vinifera* L.) belong to the grape family (*Vitaceae*), a large botanical family comprising approximately 16 genera, the most significant of which is the genus *Vitis*. This genus is cyclically divided into two main sections: one under the subgenus *Muscadina* and the other under the subgenus *Euvitis*. [1, 2]. The latter includes most Vitis species, which are further classified into three groups based on their geographic origin: the American species group, comprising the majority of the germplasm; the Euro-Asian species group (species from Europe and Western Asia), which includes (*Vitis vinifera* L.) the species that encompasses table grape varieties; and finally, the Asian grape group (species from East Asia). With around 950 species worldwide, the European grape (*Vitis vinifera* L.) is the most economically and agriculturally important [3, 4], having its origin in the Mediterranean and Middle Eastern regions and being widely used for fresh consumption as well as in various industries [4, 5].

Grape cultivation is one of the oldest horticultural practices in Yemen and one of the most important crops reflecting the country's agricultural and cultural heritage [6]. Globally, grape production reached approximately 78 million tons in 2020, with China ranking first at over 14.7 million tons, followed by Italy, Spain, France, and the United States [7]. In the Arab world, Egypt leads with about 1.59 million tons, followed by Iraq, Morocco, Syria, Tunisia, Yemen, Lebanon, and Libya [7].

Local statistics indicate a decline in the area planted with grapes in Yemen; the cultivated area decreased from approximately 13,246 hectares with a production of 146,730 tons in 2015 to 12,199 hectares with a production of 145,591 tons in 2021 [8]. This decline can be partly attributed to the widespread cultivation of qat (*Catha edulis* Forssk.) in areas designated for grape production.

Yemeni grapes are known for their remarkable diversity. Historical sources mention about 40 landraces of grapes [9] and 18–20 additional landraces, five of which were not included in the previous count [10]. Furthermore, ancient Yemeni inscriptions and historical studies indicate that grape cultivation has been widespread in various regions of ancient Yemen since time immemorial [10, 11].

Al-Dajwi [10], noted that the number of grape varieties in Yemen ranges between 20 and 40, with the most common ones classified by color into three categories: light (white), red, and black, each comprising several varieties.

The characterization and classification of grape varieties are crucial in breeding programs, relying on precise criteria established by international bodies such as the International Organization of Vine and Wine (OIV) [12], the International Board for Plant Genetic Resources (IPGR /IBPGR) [13], and the International Union for the Protection of New Varieties of Plants (UPOV) [14]. This classification has contributed to the development of advanced grape characterization and breeding methods, resulting in more accurate and effective agricultural programs. Specialized organizations have emphasized the need to establish grape germplasm collections and to support international cooperation for the characterization and evaluation of grape varieties [12].

In this context, several studies have been carried out in different countries to characterize the morphological traits of grape varieties. For example, in Algeria, Laidi Zian [15] characterized 34 local varieties in 2009, while Hmimsa *et al.*, [16] found clear differences in cluster, berry, and seed traits among 36 in Morocco grapes varieties based on international standards. Similarly, Mahmoud *et al.*, [17] conducted a 58 morphological characterization of ten varieties distributed across seven Egyptian governorates.

In Yemen, local grape varieties including A'asmi—exhibit unique characteristics that necessitate in-depth scientific studies to document and characterize them, given the scarcity of comprehensive sources on local grape landraces. The first study in this regard was conducted in 1981 by Al-Sawaaf [18], who described 12 Yemeni grape varieties, notably including Bayad, Razqi, A'asmi, Aswad, Arqi, Hatmi, and Zaytoun, in addition to other less common varieties. This study concluded that all these varieties belong to *Vitis vinifera* L., but are classified within the Eastern grape group (*Orientalis Negr.*), which is prevalent in the Middle East and Central Asia.

Al-Ward [19] initiated the establishment of a pomological database specific to Yemen, identifying 18 grape varieties cultivated in the country. His work included the morphological characterization of 16 varieties and an ecological analysis of 10 varieties during the 1987 and 1988 seasons, confirming that all belong to *Vitis vinifera* L. Later, Al-Ward and Al-Maidama [20] conducted a comparative study between the regions of Sana'a and Saada to assess the impact of environmental conditions on the A'asmi and Razqi varieties. The results showed that the A'asmi Cultivar cultivated in Sana'a achieved higher average cluster weight and size, as well as a higher percentage of soluble solids, compared to that in Saada, while no significant differences were found in total acidity between the two regions.

Al-Dals *et al.*, [21] conducted a morphological study on local grape landraces in the Northern Highlands, which included 14 grape varieties among them Bayad, Razqi, A'asmi, Aswad, Jabri, and others. Their study highlighted clear differences in vegetative and fruit traits among the examined varieties.

A'asmi Cultivar is considered one of the high-value economic varieties due to its relatively large berry size. According to Al-Shawish [6], the average berry weight is 8.5 grams, with an average length of 2.35 cm and width of 2.43 cm. Each berry contains between 1 and 4 seeds, with an average seed weight of 0.05 grams. Chemical analyses revealed a notable increase in soluble sugar content (20.77 °Brix) and a decrease in acidity to 0.40%, with a recorded pH of 4.40.

This Cultivar stands as a cornerstone in the Yemeni grape cultivation system, with studies demonstrating significant variations in its morphological traits and chemical properties. In light of ongoing climate changes and agricultural challenges, further research on this Cultivar is urgently needed to ensure the sustainability of its cultivation and to improve its productivity. The study aims to bridge the knowledge gap in the characterization of Yemeni grapes and to make a scientific contribution to enhance breeding programs and preserve this heritage.

Despite the historical and economic importance of grapes, current studies still lack sufficient documentation and analysis of grape varieties, whether extinct or commercially cultivated. Accordingly, the study sought

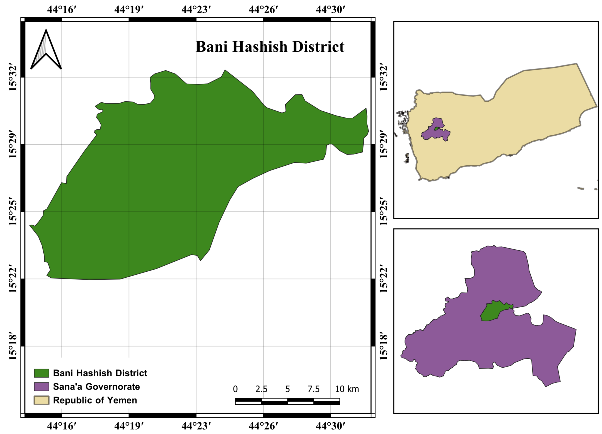

Figure 1. Geographic location of the study area in Bayt al-Nukhif village (Wadi Al-Sar, Bani Hushish District, Yemen). The site (15.49°N, 44.37°E; 2,247 m elevation) represents Yemen's premier grape cultivation region, distinguished by its high-altitude agroecology

to conduct a detailed morphological characterization of the A'asmi Cultivar using key pomological traits such as those of young, mature, and lignified shoots; young and mature leaves along with their petioles; and the flowers and fruits (clusters, berries, and seeds) based on IPGR, UPOV, and OIV standards and previous studies—and to establish a comprehensive database compiled from international standards and prior research. This database is intended to serve as a foundation for future breeding programs, support the preservation of genetic diversity, and facilitate researchers' access to the desired traits.

2. MATERIALS AND METHODS

2.1. Location of Study

The research was conducted in Bayt al-Nukhif village (*Wadi Al-Sar, Bani Hushish District, Sana'a Governorate, Yemen*; 15.49°N, 44.37°E), a high-altitude agroecological zone situated at 2,247 meters above sea level (Figure 1). This region is the epicenter of grape cultivation in Yemen, dominating regional production in both yield and quality, as documented in prior studies [8]. Its unique elevation and climatic conditions render it a critical agricultural hotspot for viticulture.[8].

2.2. Soil, water, and climate characteristics of the study location

The study spanned two growing seasons (2021–2022), during which chemical and physical analyses were conducted on soil and water (Tables 1 and 2). Additionally, the following climate data were recorded: maximum temperature (Figure 2a), precipitation amount (Figure 2b), average temperature and precipitation (Figure 2c), and wind speed (Figure 2d).

Table 1. Physicochemical characteristics of groundwater in the Bayt al-Nukhif agricultural region (Yemen).

Measured Property	Symbol	Unit	Result*
pH Level	pH	-	7.70
Total Dissolved Solids	TDS	ppm	480
Electrical Conductivity	EC	$dS{\cdot}mt^{-1}$	0.75
Calcium	Ca^{2+}	ppm	64
Magnesium	Mg^{2+}	ppm	42
Sodium	Na^{+}	ppm	24
Potassium	K^{+}	ppm	0.3
Chloride	Cl^{-}	ppm	105
Bicarbonate	HCO_3^{-}	ppm	268.7
Sulfate	SO_4^{2-}	ppm	25.25
Sodium Adsorption Ratio	SAR	%	0.56

*Values represent the mean of three replaces

Table 2. Physicochemical properties of agricultural soils in Bayt al-Nukhif (Yemen).

Property	Symbol	Unit	Result*
Soil Reaction (pH)	PH	–	7.42
Electrical Conductivity	EC	$dS{\cdot}m^{-1}$	0.8032
Total Dissolved Solids	TDS	ppm	512
Total Nitrogen	N total	%	0.135
Available Phosphorus	P_2O_5	ppm	9.16
Available Potassium	K_2O	ppm	186.5
Organic Matter	O.M	%	2.69
Calcium Carbonate	$CaCO_3$	%	18.5
Bulk Density	Db	–	1.5
Sodium Adsorption Ratio	SAR	%	2.95
Cation Exchange Capacity	CEC	%	74.2
Dissolved Cations and Anions			
Available Calcium	Ca^{2+}	$Meq{\cdot}L^{-1}$	4
Available Magnesium	Mg^{2+}	$Meq{\cdot}L^{-1}$	3
Sodium	Na^{+}	$Meq{\cdot}L^{-1}$	4.70
Bicarbonate	HCO_3	$Meq{\cdot}L^{-1}$	0.6
Sulfate	SO_4^{2-}	$Meq{\cdot}L^{-1}$	0.21
Micronutrients			
Iron	Fe	Ppm	0.78
Manganese	Mn	ppm	3.44
Copper	Cu	ppm	2.55
Zinc	Zn	ppm	6.52
Chloride	Cl	$Meq{\cdot}L^{-1}$	2.8
Soil Fractions			
Sand	–	%	20
Silt	–	%	68
Clay	–	%	12
Soil Texture	Silty loam		
Color	Yellowish brown		

*Values represent the mean of three replaces

2.3. An ampelographic study

An ampelographic study was carried out on A'asmi grape Cultivar according to internationally accepted guidelines for plant Cultivar characterization [12–14], while also considering discrepancies among these standards and drawing on previous studies [22, 23].

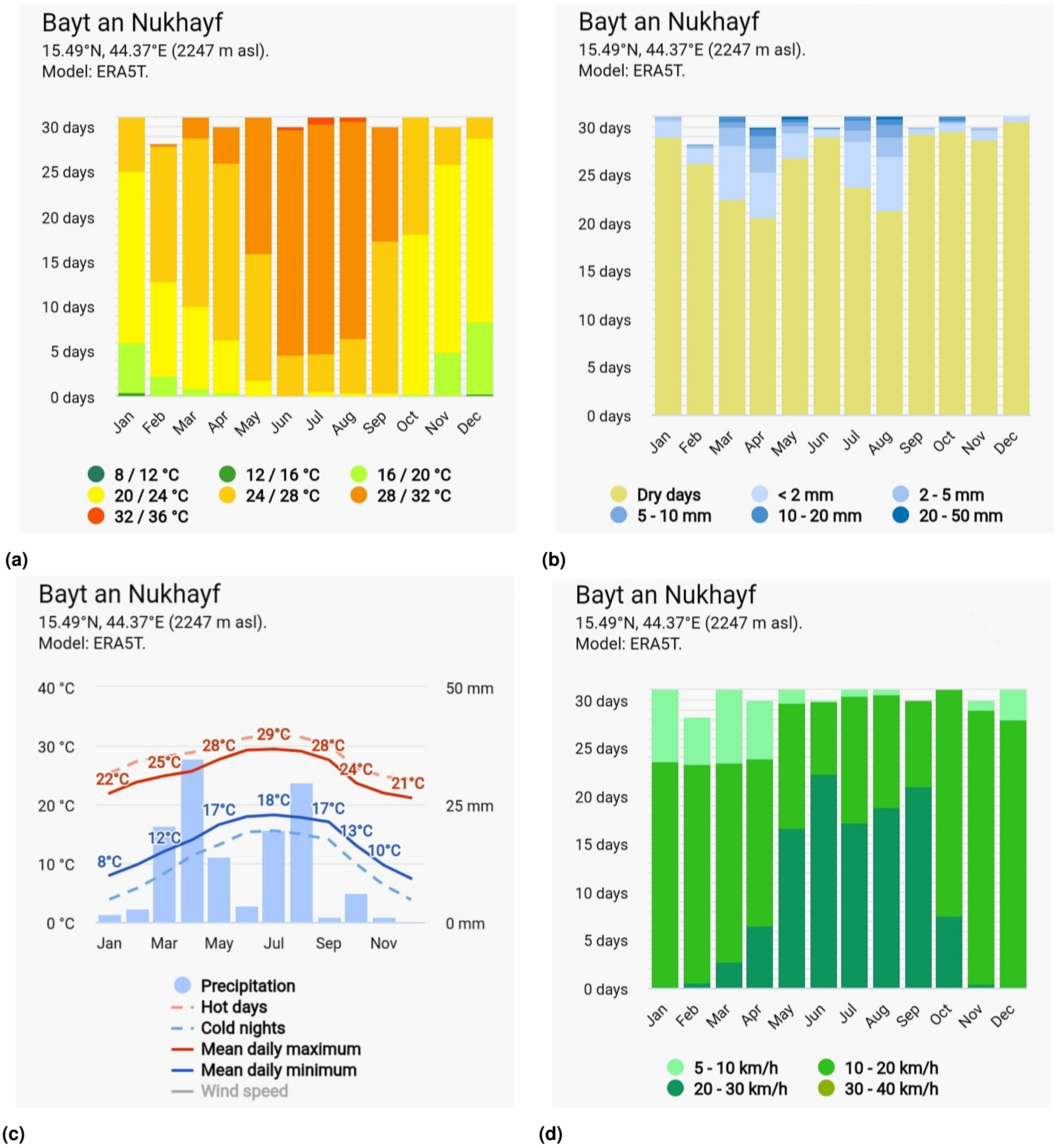

Figure 2. Climatic Conditions in Bayt al-Nukhif (study location), (a) Maximum Temperature: Shows peak temperatures recorded, likely highlighting seasonal variations critical for grape cultivation,(b) Precipitation Amount, Illustrates rainfall patterns, indicating periods of water availability/drought stress,(c) Average Temperature and Precipitation Combines mean temperature and rainfall trends, revealing agroclimatic suitability for viticulture and (d) Wind Speed: Displays wind dynamics, which may affect pollination, pest dispersal, or soil erosion.

The study focused on three principal shoots per vine following the dormancy phase, with weekly farm visits to monitor the development of morphological traits. The traits examined included those of the shoots (young, mature and lignified), the leaves (young, mature, and their petioles), as well as those of the flowers and fruits (clusters, berries, and seeds).

Data were collected following the aforementioned standards, and any observed variations were documented to ensure comprehensive and precise characterization. Quantitative traits such as leaf area, leaf length, and width, pedicel length, cluster length and width, and berry length and width were measured using the Tomato Analyzer 3.0 software, according to the methods described by Al-Madhagi and Al-Sharaqi [24], while other traits, including the angles between veins, seed length, and width, and tooth length and width, were measured using ImageJ-win64 [25].

2.4. Chemical characters of berry

Chemical analyses of the grape juice were performed in the Department of Horticulture and its Technologies laboratory. Seventy-five berries were collected and distributed into three replicates (each containing 25 berries). The juice was prepared by manually crushing the berries with the aid of a white cloth. The chemical composition of berry juice was analyzed through the following parameters and methodologies:

i. Total Soluble Solids (TSS) Determination
Total soluble solids (TSS, °Brix) were measured using a calibrated manual refractometer. Before analysis, the refractometer was standardized with distilled water (0 °Brix) and verified with a sucrose standard (e.g., 20 °Brix). Triplicate measurements were performed for each juice sample for every replicate at 20 °C, with temperature correction applied when necessary.

ii. pH Determination
The hydrogen ion concentration (pH) was measured using a calibrated digital pH meter following standardized protocols. Before measurements, the instrument was calibrated at 25 °C using NIST-traceable buffer solutions (pH 4.01 ± 0.02, 7.01 ± 0.02, and/or 9.21 ± 0.02). Triplicate measurements were performed on each juice sample under constant temperature conditions (25 ± 1 °C), with agitation to ensure homogeneity.
Total organic acid content (%): Table 3: Comparative Analysis of Selected Physical and Chemical Fruit Quality Parameters for the 2021 and 2022 Seasons

iii. tartaric acid equivalents were determined by potentiometric titration with 0.1 N NaOH, following AOAC Method 942.15 (Harvey [25]). Assuming tartaric acid as the predominant acid (pKa_1 = 2.98, pKa_2 = 4.34), the endpoint was identified at pH 8.2 ± 0.1. Results were calculated as:

$$\%\text{Organic Acids} = \frac{V_{\text{NaOH}} \times N \times \text{EWTA} \times 100}{V_{\text{sample}} \times 1000} \quad (1)$$

Where: VNaOH= Titrant volume (mL), N= NaOH normality (0.1 eq/L, EWTA= Tartaric acid equivalent weight (75 g/eq), Vsample= Juice aliquot volume (mL).

iv. Ascorbic Acid (Vitamin C) Quantification
Vitamin C content was determined by iodometric titration using a standardized 1% (w/v) iodine solution with a 1% starch indicator as the endpoint indicator, following the method of Al-Ajtel et al., [26]. The concentration of ascorbic acid was calculated as:

$$\text{Vitamin C (g/L)} = \frac{1000 \times V_{\text{titrant}} \times 0.0088}{V_{\text{sample}}} \quad (2)$$

where: Vtitrant = Average titration volume (ml), 0.0088 = conversion factor (g / ml) based on iodine-ascorbic acid stoichiometry (1: 1 molar ratio) and Vsample = volume of juice tested (ml).

2.5. Data organization and analysis

All the traits mentioned in the international standards, in addition to some traits derived from previous studies, were compiled into a unified table designed to simplify the grape characterization process and facilitate researchers' rapid access to the required information without extensive searching. The table included 105 traits, some of which were not mentioned in the international standards and were designated with the code **"TE0-10"** (Appendix 1).

3. RESULTS AND DISCUSSION

3.1. Ampelographic study

Young shoot

The ampelographic study of the young shoot of A'asmi has remarkable consistency in its morphological traits. A fully open apex was observed on the young shoot before the first node (Figure 3), a characteristic associated with vigorous vegetative growth that enhances the cultivar's suitability for cultivation in regions with long warm seasons. However, the anthocyanin coloration on the prostrate hairs of the tip was very weak, which may reflect a limited genetic expression of this pigment in the cultivar, serving as an indicator of the plant's response to environmental stresses such as ultraviolet radiation or low temperatures. Additionally, the results indicated that the density of prostrate and erect hairs on the shoot tips and along the shoot edges was very sparse. This trait is of ecological and functional importance; reduced trichome density decreases the plant's ability to retain moisture, yet it could improve ventilation around the green tissues and thereby reduce the incidence of fungal diseases [27]. These findings are consistent with those reported by [21] and appear to agree with the observations of Mahmoud *et al.,* [17], which noted similarities between the A'asmi cultivar and the Romy Ahmer type.

Mature Shoots

The results for mature shoots showed stable morphological traits with no significant differences between the two growing seasons. The growth attitude before tying was semi-erect (Figure 4), reflecting a predominantly erect growth habit of this Cultivar.

Dorsal Side Between Two

The dorsal side between two buds or nodes exhibited a reddish-green coloration, while the ventral side remained green (Figure 5), indicating a balanced distribution of pigments in the young shoot.

Hair Density

Morphological analysis revealed two distinctive traits in 'A'asmi': (i) significantly reduced pubescence, with both erect and prostrate trichomes being either absent or minimally present on nodes and internodes (Figure 6), and (ii) negligible anthocyanin accumulation in bud scales (Figure 7). This glabrous phenotype and lack of

Figure 3. The openness of tip form shoots in the A'asmi cultivar.

Figure 4. Shoot growth orientation pre-cane positioning.

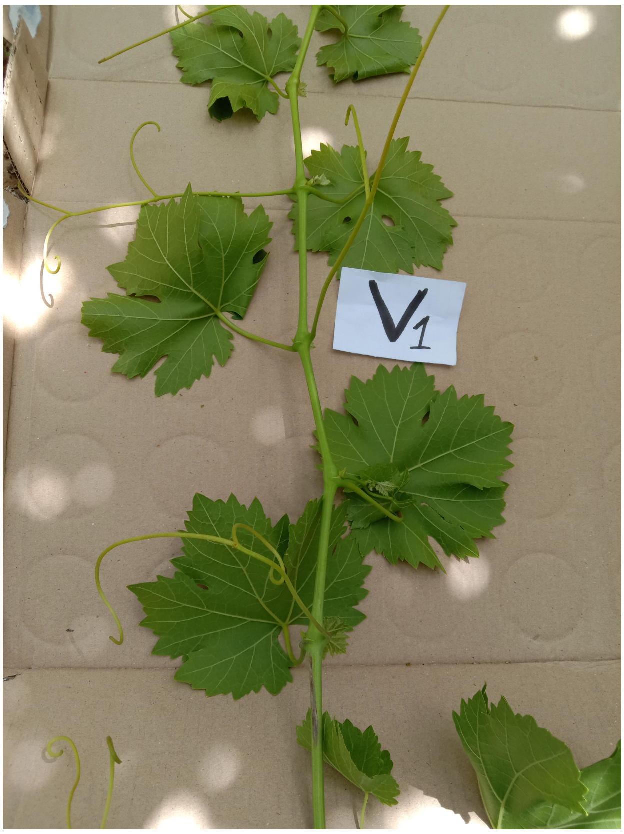

Figure 5. Color of the ventral side between two buds or nodes and color of the ventral side color of the nodes.

Figure 6. Density of erect and prostrate hair between two nodes and on the nodes.

pigmentation may reflect cultivar-specific genetic determinants or phenotypic plasticity in response to local growing conditions. The concurrent absence of these typical morphological markers suggests 'A'asmi' may represent either a distinct ecotype adapted to a specific environment or a unique genotype with suppressed trichome development and anthocyanin biosynthesis pathways.

Successive Lateral Shoots

The morphological evaluation of 'A'asmi' revealed several distinctive architectural features. Most notably, the cultivar exhibited vigorous lateral shoot development, consistently producing three or more successive orders of branching (Figure 8). This prolific branching pattern provides significant structural and functional advantages, including enhanced mechanical stability through increased node density and improved load distribution across the vine structure [26]. The multiple branching orders facilitate superior anchorage to support systems, particularly in pergola training configurations, while simultaneously improving resistance to environmental stressors such as wind. These growth characteristics suggest 'A'asmi' possesses inherent traits that promote both structural integrity and adaptability to various cultivation systems. The observed branching architecture may contribute to reduced trellis maintenance requirements and improved long-term vineyard sustainability.

Length of Lateral Shoots

The lateral shoots of 'A'asmi' displayed consistent morphological characteristics, with an average length of

Figure 7. Distribution and intensity of anthocyanin coloration on the bud scales.

Figure 8. Number of consecutive tendrils.

18.25 cm recorded across both growing seasons. This Lateral shoot length reflects an optimal balance between vegetative growth and structural functionality, providing sufficient biomass for photosynthesis while maintaining the mechanical strength required for secure attachment to training systems, effective load distribution across vine architecture, and resistance to environmental stressors. The stability of this trait across multiple seasons (p>0.05) confirms its reliability as both a diagnostic morphological marker for cultivar identification and a key determinant of the vine's training system adaptability. These consistent growth patterns suggest 'A'asmi' possesses genetically regulated they can be considered reliable morphological indicators for classifying and characterizing A'asmi "cv"

Woody Shoot

The anatomical examination of 'A'asmi' shoots revealed superior woody tissue characteristics, demonstrating three distinctive morphological features: (i) consistently elliptical transverse sections indicating balanced radial growth, (ii) exceptionally smooth cutting surfaces devoid of wrinkles or structural defects, and (iii) uniform yellowish-brown coloration in mature shoots (Figure 9). These traits collectively reflect advanced tissue differentiation and optimal lignification, suggesting exceptional shoot maturity and structural integrity. The observed anatomical regularity - particularly the flawless sectioning quality - exceeds typical commercial standards and shows remarkable phylogenetic similarity to Romy Ahmer cultivars [15]. Such coherent woody development not only confirms the cultivar's morphological distinctiveness but also indicates significant potential for high-success propagation applications, including grafting and rootstock development. The consistency of these features across multiple growth stages further establishes their reliability as diagnostic markers for 'A'asmi' identification in vineyard management and breeding programs.

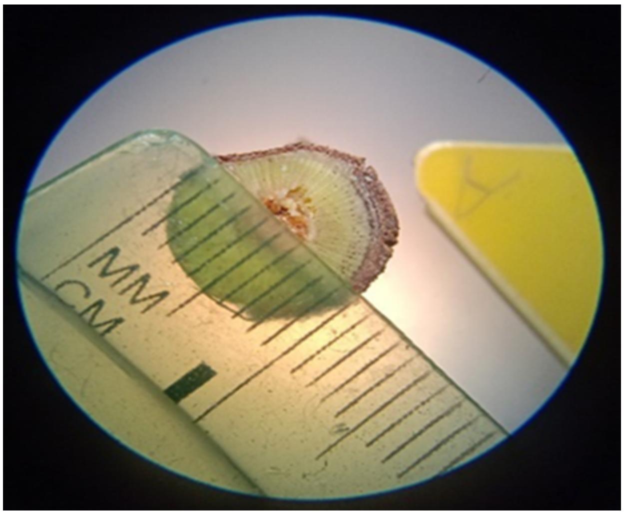

Figure 9. Cross section of the shoot, and the structure of the woody shoot surface after cutting.

Young Leaves

The evaluation of young leaves indicated a distinct trait in which the color of the upper side of the blade toward a yellowish-green coloration (Figure 10),potentially a physiological state related to photosynthetic activity or adaptation to environmental conditions findings that align closely with previous reports by Dilli *et al.,* [28] .

Mature Leaves

Quantitative analysis of mature leaves (nodes 8-11) revealed consistent morphological parameters, with an average leaf area of 125.86 cm^2 (length: 13.59 cm; width: 14.01 cm), confirming the cultivar's stable foliar architecture. The leaves exhibited five distinct lobes in a characteristic wedge-shaped configuration, with uniform green pigmentation of the upper surface (Figure 11) - findings that align closely with previous reports by Al-Dals *et al.,* [21] and Pavloušek [29]. Notably, anthocyanin accumulation was undetectable in the primary venation system, as demonstrated by the complete absence of pigmentation in both adaxial and abaxial surfaces (Figure 12). These results collectively indicate (i) high phenotypic stability in foliar development, phylogenetic consistency with documented characteristics of this cultivar group, and (iii) potential adaptation to high-light environments through

Figure 10. Color of the upper side of young leaves.

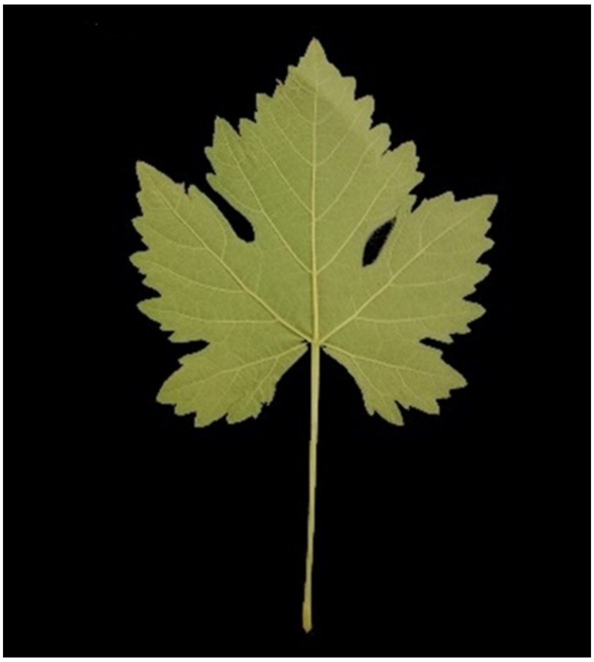

Figure 11. The shape and color of the mature leaf, the color of the petiole, the number of lobes, and the anthocyanin coloration of the main veins on the lower and upper sides of the blade.

reduced anthocyanin-dependent photoprotection mechanisms.

Anthocyanin Present

The foliar analysis demonstrated two distinctive morphological characteristics of 'A'asmi': complete absence of anthocyanin pigmentation in primary veins on both leaf surfaces (Figure 9) and minimal pubescence, with erect and prostrate trichomes being either absent or sparsely distributed in interveinal areas (Figure 12) and along main veins (Figure 13). This glabrous phenotype, coupled with the lack of venation coloration, suggests evolutionary adaptation to environmental conditions, e.g., high-light environments or arid climates. The consistent expression of these traits across all sampled leaves indicates strong genetic control rather than phenotypic plasticity. From an agronomic perspective, these characteristics may confer several advantages: (ii) enhanced photosynthetic efficiency due to unobstructed light penetration, (ii) reduced microhabitats for pathogen establishment, and (ii) improved drought tolerance through minimized surface transpiration. These morphological features provide reliable diagnostic markers for cultivar identification while suggesting potential breeding value for developing stress-resistant grapevine varieties.

Leaf Petioles, Venation Angles, and Teeth

Comprehensive foliar analysis of 'A'asmi' revealed distinct morphological traits with potential agronomic significance. The petioles averaged 97.05 mm in length consistently shorter than the midrib (117.15 mm) while venation patterns showed progressive shortening from primary (L1: 117.15 mm, short) to tertiary veins (L5: 18.9 mm, short). Notably, vein angles demonstrated optimal photosynthetic geometry, particularly angle F (60.37°), which may enhance light capture efficiency. Leaf teeth exhibited bilateral symmetry (Figure 14) with size dimor-

Figure 12. Density of erect and prostrate hairs between veins on the lower surface.

phism (N2: 10.6 × 14.25 mm; N4: 8 × 11.85 mm), consistent with previous reports [19]. A hallmark trait was the complete absence of trichomes on veins and petioles, a distinctive feature that may reduce drought/pest resistance but improve ventilation and fungal disease resistance.

Interannual comparisons revealed enhanced vegetative growth in 2022, likely due to increased rainfall (560% higher than 2021 levels during the fruit set). Despite these environmental influences, key traits including lobe number, anthocyanin absence, and tooth morphology remained stable, highlighting strong genetic control. These findings align with Pavloušek [30] and Zian [15]. Regarding phylogenetic similarities to Mi-5-114 genotypes, as well as Mahmoud et al. [17] and [27, 30] for Romy Ahmer cultivars.

Figure 13. Density of erect and prostrate hairs on main veins on the lower side of the blade.

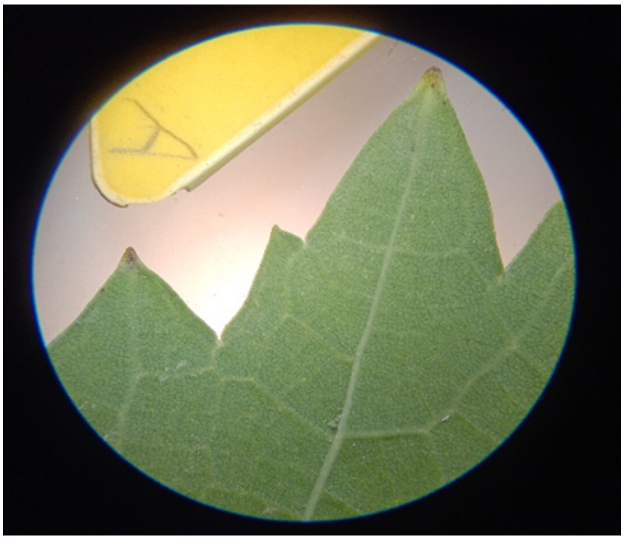

Figure 14. Shape of teeth.

The observed foliar architecture suggests; enhanced the observed foliar architecture suggests; enhanced photosynthate transport through enlarged L1/L2 vasculature, improved disease management via reduced trichome-mediated pathogen retention, enhanced photosynthetic efficiency due to unobstructed light penetration via wide-angle venation and climate adaptation tradeoffs, as shorter N4 teeth may indicate limited xeric adaptation warranting yield-quality correlation studies.

Floral Traits

The floral analysis confirmed that 'A'asmi' produces fully bisexual flowers containing functional male (stamens) and female (pistils) reproductive structures (Figure 15). This hermaphroditic floral morphology provides key adaptive advantages: (i) ensured reproductive success through self-pollination when pollinators are scarce, (ii) maintained potential for cross-pollination to preserve genetic diversity, and (ii) enhanced environmental adaptability to variable climatic conditions. The flowers showed complete symmetry in reproductive organ development,

Figure 15. Sex of flower.

with stamens positioned at an optimal angle relative to the central pistil, facilitating efficient pollen transfer. This balanced floral architecture suggests high fertility potential and makes 'A'asmi' particularly suitable for both conventional vineyards and breeding programs. The presence of fully developed bisexual flowers also indicates this cultivar's evolutionary adaptation to ensure a reliable fruit set regardless of pollination conditions, while still benefiting from genetic diversity through occasional outcrossing. These reproductive characteristics position 'A'asmi' as a valuable genetic resource for developing resilient grape varieties in the face of changing environmental conditions and pollinator declines.

Bunch length

The data collected over two growing seasons indicate that the cluster traits of A'asmi *"cv"* exhibit cohesion, reflecting a balanced response to both environmental and genetic factors. The average bunch length was approximately 26.95 cm, with an average width of about 11.99 cm, classifying the bunch as "long" with a slight tendency toward broader dimensions. The distribution of berries within the bunch was observed to be loose (Figure 16).

Cluster peduncle measurements revealed an average total length of about 29.62 cm, with the portion from the attachment point on the shoot to the first branching point measuring 24.5 cm, and additional intermediate measurements averaging 15 cm. The bunch contained an average of about 253 berries, indicating improved productivity and fertilization efficiency. In terms of shape, the

bunch was classified as "long cylindrical" with no lateral appendages on the primary bunches (Figure 16), confirming its regular and upright form.

Bunch weight

Regarding weight and volume, the average bunch weight was approximately 444.46 g, with an average volume was 550.5 cm^3, which may indicate changes in the composition or proportions of the cluster parts. These dimensional and weight measurements suggest that the observed changes in cluster traits represent an adaptive response to fluctuating environmental conditions, accom-

Figure 16. Bunch of A'asmi.

panied by improvements in performance traits such as berry number and biomass distribution.

Berries Shape

The berries consistently exhibited a spherical shape, with skin coloration ranging between red and pink, reflecting high-quality fruit attributes under specific environmental and agronomic practices. The average berry length and width were approximately 2.54 cm, and 2.48 cm, respectively, aligning with the values reported by Makhoul et al., [31] for the M2 type. Berry's skin thickness showed a slight decrease, averaging 0.125 mm. Although anthocyanin expression in the pulp was very weak (Figure 17), the berries maintained a very firm (crisp) texture pulp and a pleasant flavor. The average berry weight was approximately 8.06 g, and the weight of 100 berries averaged around 691.5 g, consistent with finding from previous studies [6, 31, 32], indicating stable weight with only minor seasonal variations. These results suggest that the berries preserve their qualitative traits in terms of shape, firmness, and flavor despite slight fluctuations in size and weight. This stability reflects the precise physiological response to environmental variables and underscores the need for further studies to elucidate the underlying mechanisms and their implications and their impact on production quality.

Seed Morphology

The study on seed morphology indicated that the basic dimensions of the seeds were stable, although differences in biomass accumulation were noted, which may be influenced by growth

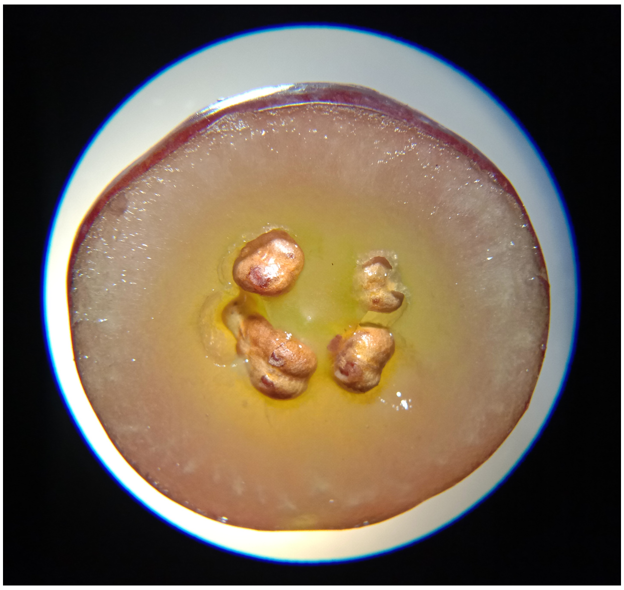

Figure 17. Anthocyanin coloration of flesh color.

conditions. The average seed length was conditions. The average seed length was recorded at 7.78 mm (Figure 18) and the average width at 4.59 mm, indicating consistency among the samples.

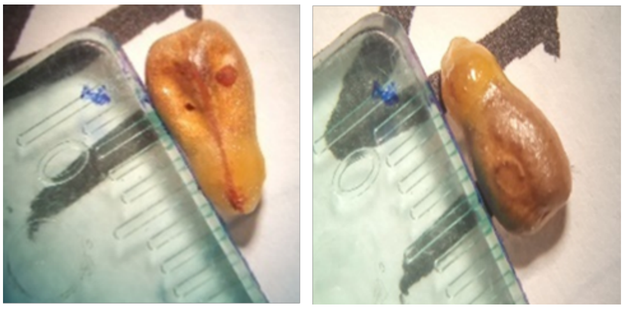

Figure 18. Seed length.

However, the weight of 100 seeds differed significantly between the two years, measuring 5.47 g in 2021 and 4.12 g in 2022 (Table 2), with an overall average of approximately 4.80 g, which places the seeds in the very low weight category. This reduction may reflect environmental influences or specific agronomic practices affecting seed biomass accumulation. The seed surface showed no transverse ridges, and the seed coat maintained a stable brown color, indicating consistent pigment composition (Figure 19). Additionally, the number of seeds per berry varied from one to four (Figure 19). The average number of seeds in the cluster for 9 clusters, was 301.5, suggesting the need for further investigation into the relationship between seed distribution and other fruit traits. Moreover, the low profile of the chalaza (Figure 20) may indicate differences in tissue distribution or nutrient allocation within the berry.

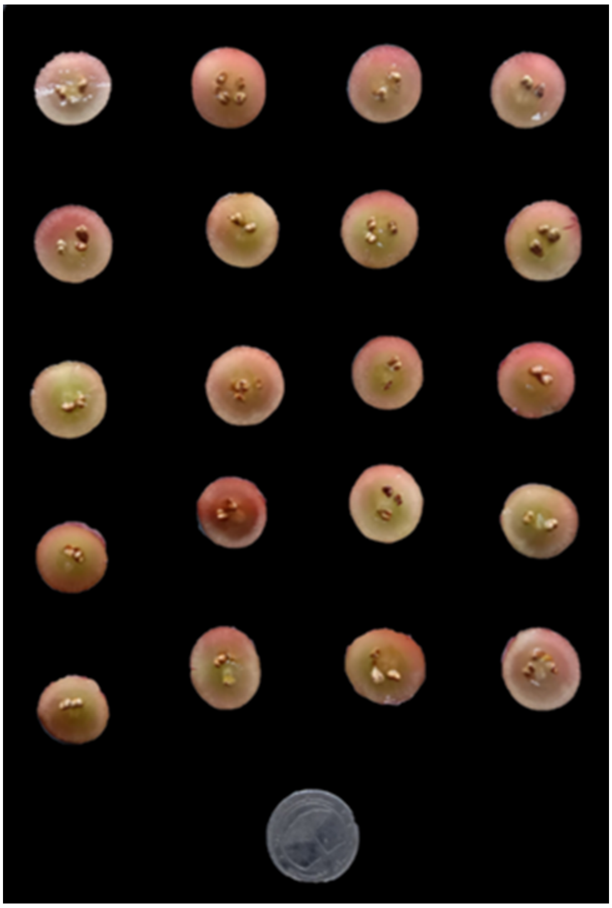

Figure 19. Cross section of 20 A’asmi berries showing the number of seeds per berry.

Figure 20. Chalaza form.

3.2. Chemical characters of berry

The analysis of the quality of grape juice revealed a significant increase in total soluble solids (T.S.S) rising from 16.50 °Brix in 2021 to 19.96 °Brix in 2022 (Table 3), suggesting improved ripeness or enhanced sugar accumulation, likely driven by environmental or agronomic factors. This level is considered medium, making the grapes suitable for both fresh consumption and processing.

Table 3. Comparative Analysis of Selected Physical and Chemical Quality Parameters for the 2021 and 2022 Seasons

The measured characteristic	Season	
	2021	2022
Weight of 100 seeds	5.47	4.12
Total Soluble Sugars (T.S.S) (Brix)	16.50	19.96
Hydrogen Ion Concentration (PH)	3.84	3.66
Total Acidity (TIA)	0.36	0.58
Ascorbic Acid (Vitamin C) Ripening Date	0.50	0.53

Titratable acidity also increased significantly from 0.36% in 2021 to 0.58% in 2022, though it remained within a very low level, which may affect the sweetness /acidity balance, particularly relevant given that the A’asmi cultivar is primarily intended for table grape consumption rather than for juice production. The pH value decreased slightly from 3.84 to 3.66, indicating a modest increase in acidity that could enhance the perception of sourness, although still within acceptable limits for most grape cultivars.

Vitamin C (ascorbic acid) content (mg/100 fresh weight) remained relatively stable, with a slight increase from 0.50 mg to 0.53 mg, reflecting consistency in the nutritional value of the berries despite variations in sugar and acidity levels.

These results align with the reports of Al-Shawish [6] and Al-Ward and Al-Maidama [20].

The observed increase in sugar content may be indicative of improved ripeness or favorable climatic conditions, while the rise in titratable acidity and a corresponding decrease in pH suggests a potential shift in flavor dynamics. The stable vitamin C content further confirms that the nutritional composition is unaffected by these chemical changes.

4. CONCLUSION

The research highlights that the -Asmi grape cultivar constitutes an integral part of Yemen’s agricultural heritage. The finding indicates a remarkable consistency between the recorded morphological traits and previous descriptions, with only minor differences likely attributable to environmental factors or analytical techniques. The study underscores the importance of preserving this unique Cultivar in terms of both productivity and quality, while also emphasizing the need for further genetic and environmental research. Additionally, a unified table containing 105 traits was developed—incorporating those not mentioned in the international standards (designated with the code TE0-10) to facilitate the grape characterization process and enable researchers to quickly access the required information without extensive searching.

Some characters not included in the global specifications (TE0-10) have been coded to classify measurable ampelographic characters that can be applied to all (*Vitis vinifera* L.) varieties comprehensively, according to the international protocols developed by the International Organization of Vine and Wine (OIV), the International Union for the Protection of New Varieties of Plants (UPOV), and the International Plant Genetic Resources Institute (IPGRI). This systematically organized framework has been incorporated in (Table 4) to improve the efficiency of researchers by facilitating rapid identification of parameters and eliminating the need for extensive literature review in grape phenotypic characterization.

A'asmi grape cultivar (*Vitis vinifera* L.) represents a critical agro-cultural heritage resource in Yemen, with its preservation imperative for both biodiversity conservation and sustainable viticulture. This study demonstrates high morphological consistency with historical descriptors, affirming cultivar stability, while observed variances likely attributable to environmental modulation or methodological divergence warrant deeper investigation.

To address global standardization gaps, we developed a comprehensive ampelographic framework (106 traits), incorporating novel codified descriptors (TE0-10) absent in existing OIV, UPOV, and IPGRI protocols. This systematized trait matrix (Appendix 1) facilitates high-throughput phenotypic characterization eliminating reliance on fragmented literature and enabling **cross-study reproducibility.

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Table 4. Appendix 1: Morphological characters for branch traits (young, mature, and woody), leaf traits (young, mature, and petioles), flower traits, and fruit traits (clusters, berries, and seeds) using the approved characterization scales (UPOV, IPGRI, OIV) taking into account the differences between these specifications in characterizing some traits, and based on what was mentioned in previous studies [33] [22].

Qn	Young Shoot	A’asmi Cultivar	-	Code
1	Openness of Tip Form			OIV 001 UPOV 2 IPGRI 6.1.1
	Closed		1	
	Slightly Open		2	
	Half Open	*	3	
	Wide Open		4	
	Fully Open		5	
2	Intensity of Anthocyanin Coloration on Prostrate Hairs of Tip			OIV 003 UPOV 4 IPGRI 6.1.2
	Absent		0	
	Very Weak		1	
	Weak	*	3	
	Medium		5	
	Strong		7	
	Very Strong		9	
3	Density of Prostrate Hairs on Tip			OIV 004 UPOV 3 IPGRI 6.1.3
	Absent		0	
	Very Sparse		1	
	Sparse		3	
	Medium		5	
	Dense	*	7	
	Very Dense		9	
4	Density of Erect Hairs on Tip			OIV 005 UPOV 5 IPGRI 6.1.4
	Absent		0	
	Very Sparse		1	
	Sparse	*	2	
	Medium		3	
	Dense		4	
	Very Dense		5	
	Shoot		-	Code
5	Attitude (Before Tying)			OIV 006 UPOV 9 IPGRI 6.1.5
	Erect	*	1	
	Semi-Erect		3	
	Horizontal		5	

	Semi-Drooping		7	
	Drooping		9	
6	Color of Dorsal Side of Internodes			OIV 007 UPOV 10 IPGRI 6.1.6
	Green		1	
	Green and Red	*	2	
	Red		3	
7	Color of Ventral Side of Internodes			OIV 008 UPOV 11 IPGRI 6.1.7
	Green	*	1	
	Green and Red		2	
	Red		3	
8	Color of Dorsal Side of Internodes			OIV 009 UPOV 12 IPGRI 6.1.8
	Green	*	1	
	Green and Red		2	
	Red		3	
9	Color of Ventral Side of Nodes			OIV 010 UPOV 13 IPGRI 6.1.9
	Green		1	
	Green and Red	*	2	
	Red		3	
10	Density of Erect Hairs on Node			OIV 011 IPGRI 6.1.10
	Absent	*	0	
	Very Sparse		1	
	Sparse		3	
	Medium		5	
	Dense		7	
	Very Dense		9	
11	Erect Hairs on Internodes			OIV 012 UPOV 14 IPGRI 6.1.11
	Absent	*	0	
	Very Sparse		1	
	Sparse		3	
	Medium		5	
	Dense		7	
	Very Dense		9	
12	Density of Prostrate Hairs on Node			OIV 013 IPGRI 6.1.12
	Absent	*	0	
	Very Sparse		1	
	Sparse		3	
	Medium		5	

	Dense		7	
	Very Dense		9	
13	Density of Prostrate Hairs on Internode			OIV 014 IPGRI 6.1.13
	Absent	*	0	
	Very Sparse		1	
	Sparse		3	
	Medium		5	
	Dense		7	
	Very Dense		9	
14	Distribution of the Anthocyanin Coloration on the Bud Scales			OIV -015-1
	Absent	*	1	
	Up to the Middle		2	
	on the Whole Bud Scale		3	
15	Intensity of the Anthocyanin Coloration on the Bud Scales			OIV -015-2
	Absent	*	0	
	Very Sparse		1	
	Sparse		3	
	Medium		5	
	Dense		7	
	Very Dense		9	
16	Number of Consecutive Tendrils			OIV 016 IPGRI 6.1.14
	tow or less		1	
	Three or More	*	2	
17	Length of Tendrils (cm)			OIV 017 UPOV 15 IPGRI 6.1.15
	Very Short (11)		1	
	Short (14-16)		3	
	Medium (19-21)	*	5	
	Long (24-26)		7	
	Very Long (30)		9	
	Woody Shoot		-	Code
18	Cross Section			OIV 101
	Circular		1	
	Elliptic	*	2	
	Oblate		3	
19	Structure of Surface			OIV 102 IPGRI 6.1.41
	Smooth	*	1	

	Ribbed		2	
	Striate		3	
20	Main Color			OIV 103 UPOV 44 IPGRI 6.1.42
	Yellowish Brown	*	1	
	orange brown		3	
	Dark Brown		5	
	Reddish Brown		7	
	Violet		9	
	Young Leaves		-	Code
21	Color of Upper Side of Blade or Color of Leaf Upper Surface			OIV 051 UPOV 6 IPGRI 6.1.16
	Yellow Green	*	1	
	Green		2	
	Green With Anthocyanin Spots		3	
	Light Copper Red		4	
	Dark Copper Red		5	
	Wine Red		6	
22	Density of Prostrate Hairs Between Main Veins Nervures on Lower Side of Blade (4th Leaf)			OIV 053 UPOV 7 IPGRI 6.1.17
	Absent or Very Sparse	*	1	
	Sparse		3	
	Medium		5	
	Dense		7	
	Very Dense		9	
23	Density of Erect Hairs Between Main Veins on Lower Side of Blade (4th Leaf)			OIV 054 IPGRI 6.1.18
	Absent or Very Sparse	*	1	
	Sparse		3	
	Medium		5	
	Dense		7	
	Very Dense		9	
24	Density of Prostrate Hairs on Main Veins on Lower Side of Blade (4the Leaf)			OIV 055 IPGRI 6.1.19
	Absent or Very Sparse	*	1	
	Sparse		3	
	Medium		5	
	Dense		7	
	Very Dense		9	

25	Density of Erect Hairs on Main Veins on Lower Side of Blade (4 Th Leaf)			OIV 056 UPOV 8 IPGRI 6.1.20
	Absent or Very Sparse	*	1	
	Sparse		3	
	Medium		5	
	Dense		7	
	Very Dense		9	
	Mature Leaves		-	Code
26	Size of Blade (cm^2/leaf)			OIV 065 UPOV 17 IPGRI 6.1.21
	Very Small (less than 20)		1	
	Small (20-50)		3	
	Medium (50-100)	*	5	
	Large (100-150)		7	
	Very Large (more than 150)		9	
27	Length of Blade (cm)			OIV -066
	Very Small (less than 10)		1	
	Small (10-15)	*	3	
	Medium (15-20)		5	
	Large (20- 25)		7	
	Very Large (more than 25)		9	
28	Width of Blade (cm)			TE0 (Al- wared and al-maidama [22] (Makhoul *et al.,* [5])
	Very Small (less than 5)		1	
	Small (5-7)		3	
	Medium (7-10)		5	
	Large (more than 10)		7	
	Very Large (12)	*	9	
29	Shape of Blade			OIV 067 UPOV 18 IPGRI 6.1.22
	Cordate		1	
	Wedge-Shaped	*	2	
	Pentagonal		3	
	Circular		4	
	Kidney-Shaped		5	
30	Number of Lobes			OIV 068 UPOV 20 IPGRI 6.1.23
	one		1	
	Three		2	
	Five	*	3	
	Seven		4	

	More Than seven		5	
31	Coloure of Mature Leaf Upper Surface			OIV 069
	Yellow Green		1	
	Green	*	2	
	Green With Anthocyanin Spots		3	
	Light Copper Red		4	
	Dark Copper Red		5	
	Wine Red		6	
32	Anthocyanin Coloration of Main Veins on Upper Side of Blade			OIV 070
	Absent	*	1	
	Only at the Petiolar Point		2	
	Up to the 1st Bifurcation		3	
	Up to the 2nd Bifurcation		4	
	Beyond the 2nd Bifurcation		5	
33	Area of Anthocyanin Coloration of Main Veins on Lower Side of Blade			OIV 071
	Absent	*	1	
	only at the Petiolar Point		2	
	Up to the 1st Bifurcation		3	
	Up to the 2nd Bifurcation		4	
	Beyond the 2nd Bifurcation		5	
34	Profile of Blade in Cross-Section			OIV 074 IPGRI 6.1.25
	Flat		1	
	V-Shaped	*	2	
	Involute		3	
	Revolute		4	
	Undulate		5	
35	Blistering of Upper Side of Blade			OIV 075 UPOV 19 IPGRI 6.1.26
	Absent or Very Weak	*	1	
	Weak		3	
	Medium		5	
	Strong		7	
	Very Strong		9	
36	Shape of Teeth			OIV 076 UPOV 26 IPGRI 6.1.27
	Both Sides Concave		1	
	Both Sides Straight		2	

	Both Sides Convex	*	3	
	one Side Concave, one Side Convex		4	
	A mixture of Both Sides Straight and Both Sides Convex		5	
37	Ratio Length/Width of Teeth %			OIV 078 UPOV 25 IPGRI 6.1.29
	50-50		1	
	53-47		3	
	49.74-50.26	*	5	
	49.67-50.33		7	
	49-51		9	
38	Arrangement of Lobes of Petiole Sinus Lobes Du Sinus or Opening Overlapping of Petiole Sinus			OIV 079 UPOV 23 IPGRI 6.1.30.
	Very Wide Open		1	
	Wide Open	*	2	
	Half Open		3	
	Slightly Open		4	
	Closed		5	
	Slightly Overlapped		6	
	Half Overlapped		7	
	Strongly Overlapped		8	
	Very Strongly Overlapped		9	
39	Shape of Base of Petiole Sinus			OIV 080
	U-Shaped	*	1	
	{- Shaped		2	
	V-Shaped		3	
40	Tooth at Petiole Sinus			OIV 081-1 IPGRI 6.1.31
	Absent	*	1	
	Present		2	
41	To petiole Sinus Limited by Veins			OIV 081-2 IPGRI 6.1.32
	Absent	*	1	
	Present		2	
42	Petiole of Upper Lateral Sinus			OIV 082 UPOV 22 IPGRI 6.1.33
	Open		1	
	Closed		2	
	Slightly Overlapped	*	3	
	Strongly Overlapped		4	
43	Presence of Teeth at the Base of Upper Leaf Sinuses or Opening\Overlapping of Upper Lateral Sinus			OIV 083-2

	None	*	1	
	Frequently Occurring		2	
44	Density of Prostrate Hairs Between Main Veins on Lower Side of Blade			OIV 084 UPOV 28 IPGRI 6.1.35
	Absent or Very Sparse	*	1	
	Sparse		3	
	Medium		5	
	Dense		7	
	Very Dense		9	
45	Density of Erect Hairs Between Veins			OIV 085 IPGRI 6.1.36
	Absent or Very Sparse	*	1	
	Sparse		3	
	Medium		5	
	Dense		7	
	Very Dense		9	
46	Density of Prostrate Hairs on Main Veins			OIV 086 IPGRI 6.1.37
	Absent or Very Sparse	*	1	
	Sparse		3	
	Medium		5	
	Dense		7	
	Very Dense		9	
47	Density of Erect Hairs on Main Veins on Lower Side of Blade			OIV 087 UPOV 29 IPGRI 6.1.38
	Absent or Very Sparse	*	1	
	Sparse		3	
	Medium		5	
	Dense		7	
	Very Dense		9	
48	Prostrate Hairs on Main Veins			OIV 088 IPGRI 6.1.39
	Absent	*	0	
	Present		1	
49	Density of Prostrate Hairs Between Veins			OIV 090
	Absent or Very Sparse	*	1	
	Sparse		3	
	Medium		5	
	Dense		7	
	Very Dense		9	

50	Density of Erect Hairs Between Veins			OIV 091
	Absent or Very Sparse	*	1	
	Sparse		3	
	Medium		5	
	Dense		7	
	Very Dense		9	
51	Length of the Petiole (cm)			OIV 092
	Very Short (less than 7)		1	
	Short (7-10)	*	3	
	Medium (10-14)		5	
	Long (14-18)		7	
	Very Long (more than 18)		9	
52	Length of Petiole Compared to Length of Middle Vein			OIV 093 UPOV 30 IPGRI 6.1.40
	Much Shorter		1	
	Moderately Shorter	*	2	
	Equal		3	
53	Depth of Upper Lateral Sinuses			OIV 094 UPOV 21 IPGRI 6.1.34
	Absent		1	
	Shallow	*	3	
	Medium Depth		5	
	Deep		7	
	Very Deep		9	
54	Length of Vein N1 (mm)			OIV 601
	Very Short (75)		1	
	Short (105)		3	
	Medium (135)	*	5	
	Long (165)		7	
	Very Long (195 and more)		9	
55	Length of Vein N2 (mm)			OIV 602
	Very Short (65)		1	
	Short (85)		3	
	Medium (105)	*	5	
	Long (125)		7	
	Very Long (145 and more)		9	
56	Length of Vein N3 (mm)			OIV 603
	Very Short (35)		1	
	Short (55)		3	

	Medium (75)	*	5	
	Long (95)		7	
	Very Long (115 and more)		9	
57	Length of Vein N4 (mm)			OIV 604
	Very Short (15)		1	
	Short (25)		3	
	Medium (35)		5	
	Long (45)	*	7	
	Very Long (about 55 and more)		9	
58	Length of Vein N5 (mm)			OIV 611
	Very Short (15)		1	
	Short (25)	*	3	
	Medium (35)		5	
	Long (45)		7	
	Very Long (55 and more)		9	
59	Length Petiole Sinus to Upper Lateral Leaf Sinus (mm)			OIV 605
	Very Short (30)		1	
	Short (50)	*	3	
	Medium (70)		5	
	Long (90)		7	
	Very Long (110 and more)		9	
60	Length Petiole Sinus to Lower Lateral Leaf Sinus (mm)			OIV 606
	Very Short (30)		1	
	Short (45)	*	3	
	Medium (60)		5	
	Long (75)		7	
	Very Long (90 and more)		9	
61	Angle Between N1 and N2, Measured at the First Ramification (°)			OIV 607
	Very Small (30°)		1	
	Small (30°-45°)		3	
	Medium (46°-55°)	*	5	
	Large (56°-70°)		7	
	Very Large (70° and more)		9	
62	Angle Between N2 and N3, Measured at the First Ramification (°)			OIV 608
	Very Small (30°)		1	
	Small (30°-45°)		3	

	Medium (46°-55°)	*	5	
	Large (56°-70°)		7	
	Very Large (70° and more)		9	
63	Angle Between N3 and N4, Measured at the First Ramification (°)			OIV 609
	Very Small (30°)		1	
	Small (30°-45°)		3	
	Medium (46°-55°)	*	5	
	Large (56°-70°)		7	
	Very Large (70° and more)		9	
64	Angle Between N3 and the Tangent Between Petiole Point and the tooth Tip of N5 (°)			OIV 610
	Very Small (30°)		1	
	Small (30°-45°)		3	
	Medium (46°-55°)		5	
	Large (56°-70°)	*	7	
	Very Large (70° and more)		9	
65	Length of tooth of N2 (mm)			OIV 612
	Very Short (6)		1	
	Short (10)	*	3	
	Medium (14)		5	
	Long (18)		7	
	Very Long (22 and more)		9	
66	Width of tooth of N2 (mm)			OIV 613
	Very Narrow (6)		1	
	Narrow (10)		3	
	Medium (14)	*	5	
	Wide (18)		7	
	Very Wide (22 and more)		9	
67	Length of tooth of N4 (mm)			OIV 614
	Very Short (6)	*	1	
	Short (10)		3	
	Medium (14)		5	
	Long (18)		7	
	Very Long (22 and more)		9	
68	Width of tooth of N4 (mm)			OIV 615
	Very Narrow (6)		1	

	Narrow (10)		3	
	Medium (14)	*	5	
	Wide (18)		7	
	Very Wide (22 and more)		9	
69	Number of Teeth Between the tooth Tip of N2 and the tooth Tip of the First Secondary Vein of N2 Including the Limits			OIV 616
	Very Small (3)		1	
	Small (4)	*	3	
	Medium (5-6)		5	
	Large (7-8)		7	
	Very Large (9 and more)		9	
70	Length Between the tooth Tip of N2 and the tooth Tip of the First Secondary Vein of N2 (mm)			OIV 617
	Very Short (less than 30)		1	
	Short (30-45)		3	
	Medium (46-55)		5	
	Long (56-70)	*	7	
	Very Long (more than 70)		9	
	Inflorescence		-	Code
71	Sex of Flower			OIV 151 UPOV 16 IPGRI 6.2.1
	only Male		1	
	Predominantly Male		2	
	Male and Female Fully Developed	*	3	
	Female With Straight Stamens		4	
	Female With Reflexed Stamens		5	
	Bunch		-	Code
72	Length (cm) Cluster			OIV 202 IPGRI 7.1.5
	Very Short (less than 11)		1	
	Short (11-16)		3	
	Medium (16-21)		5	
	Long (more than 21)		7	
	Very Long (26)	*	9	
73	Cluster Width (cm)			TE1 (Al- wared and al-maidama [22] (Makhoul *et al.*, [5])
	Very Short (less than 11)		1	
	Short (11-16)		3	
	Medium (16-21)	*	5	
	Long (21-26)		7	

	Very Long (more than 26)		9	
74	Density			OIV 204 UPOV 33 IPGRI 6.2.3
	Very Lax (Berries in a Cluster with Conspicuous Spaces)		1	
	Lax (Individual Berries with Some Spaces)	*	3	
	Medium (Berries Compact, Spaces Not Visible)		5	
	Dense (Berries Not Easily Displaced)		7	
	Very Dense (Berries Compressed in Shape)		9	
75	Length of Peduncle of Primary Bunch (cm)			OIV 206 UPOV 34 IPGRI 6.2.4
	Very Short (less than 2)		1	
	Short (2-5)		3	
	Medium (5-10)		5	
	Long (more than 10)		7	
	Very Long (15)	*	9	
76	Length of the Whole Peduncle (cm)			TE2 (Al- wared and al-maidama [22] (Makhoul *et al.,* [5])
	Very Short (less than 2)		1	
	Short (2-5)	*	3	
	Medium (5-10)		5	
	Long (10-20)		7	
	Very Long (more than 20)		9	
77	Weight of Bunch or Stand Stalk (g)	15G		TE3 (Al- wared and al-maidama [22] (Makhoul *et al.,* [5])
78	Number of Fruits in the Cluster	340		TE4(Al- wared and al-maidama [22] (Makhoul *et al.,* [5])
79	Shape			OIV 208
	Long Cylindrical	*	1	
	Bread Cylindrical		2	
	Narrow Conical Broad Conical		3	
	Funnel Shaped		4	
80	Number of Wings of the Primary Bunch			OIV 209
	Absent	*	1	
	1-3 Wings		2	
	More Than 3 Wings		3	
81	Single Bunch Weight (g)			OIV 502 IPGRI 7.1.14
	Very Low (100)		1	
	Low (150-250)		3	
	Medium (350-450)		5	

	High (650-950)	*	7	
	Very High (1200)		9	
82	Average Cluster Size (cm^3)	869.5		TE5 (Al- wared and al-maidama [22] (Makhoul *et al.*, [5])
	Berry		-	Code
83	Length (mm)			OIV 220
	Very Short (less than 8)		1	
	Short (8-14)		3	
	Medium (14-20)		5	
	Long (more than 20)		7	
	Very Long (26)	*	9	
84	Width (mm)			OIV 221
	Very Small (less than 8)		1	
	Small (8-14)		3	
	Medium (20- 14)		5	
	Large (more than 20)	*	7	
	Very Large (26)		9	
85	Shape			OIV 223 UPOV 36 IPGRI 6.2.6
	Obloid		1	
	Globose	*	2	
	Broad Ellipsoid		3	
	Narrow Ellipsoid		4	
	Cylindrical		5	
	Obtuse Ovoid		6	
	Ovoid		7	
	Obovoid		8	
	Horn-Shaped		9	
	Finger-Shaped		10	
86	(Without Bloom) Color of Skin			OIV 225 UPOV 37 IPGRI 6.2.8
	Green		1	
	Yellow Green		2	
	Yellow		3	
	Yellow Rose		4	
	Rose		5	
	Red	*	6	
	Grey Red		7	

	Dark Red Violet		8	
	Blue Black		9	
87	Thickness of Skin (µm)			OIV 228 UPOV 39 IPGRI 7.1.6
	Thin (About 100)		1	
	Medium (About 175)	*	2	
	Thick (About 250)		3	
88	Anthocyanin Coloration of Flesh Color			OIV 231 UPOV 40 IPGRI 6.2.9
	Absent		0	
	Very Weak	*	1	
	Weak		3	
	Medium		5	
	Strong		7	
	Very Strong		9	
89	Must Yield (ml juice/100 g berries)			OIV 233 IPGRI 7.1.9
	Very Little (less than 50)			
	Little (50-65)		1	
	Medium (66-75)	*	2	
	High (76-90)		3	
	Very High (more than 90)		4	
	Must Yield (ml juice/100 g berries)		5	
90	Firmness of Flesh			OIV 235 UPOV 45
	Soft or Slightly Firm		1	
	Juice		2	
	Moderately Firm		3	
	Very Firm	*	4	
91	Particular Flavor			OIV 236 UPOV 42 IPGRI 6.2.12
	None		1	
	Muscat	*	2	
	Foxy		3	
	Herbaceous		4	
	Other Than Muscat, Foxy or Herbaceous		5	
92	Separation From Pedicel			OIV 240 UPOV 38 IPGRI 6.2.13.
	Difficult	*	1	
	Moderately Easy		2	
	Very Easy		3	

93	Single Berry Weight/ Mean Value of Each 100 Berries Taken from the Central Part of Bunch of 10 Bunches (g)			OIV 305
	Very Low (1)		1	
	Low (1.7-2.3)		3	
	Medium (3-5)		5	
	High (7-9)	*	7	
	Very High (12)		9	
	Seed		-	Code
94	Formation of Seeds			OIV 241 UPOV 43 IPGRI 6.2.7
	None		1	
	Rudimentary		2	
	Complete	*	3	
95	Seed Length (mm)			OIV 242 IPGRI 6.2.14
	Short (less than 5)		1	
	Medium (5-7)		2	
	Long (more than 7)	*	3	
96	Seed Width (mm)			TE6 (Al- wared and al-maidama [22] (makhoul *et al.,* [5])
	Short (less than 3)		1	
	Medium (3-5)		2	
	Long (more than 5)	*	3	
97	Average Weight of a Single Seed (mg /Seed)			(Hmimsa, 2021)
	Very Low (1.0)		1	
	Low (0.21-0.29)		3	
	Medium (0.36-0.44)	*	5	
	High (0.51-0.59)		7	
	Very High (0.65)		9	
98	Average Weight of 100 Seeds (mg /100 Seeds)			OIV 243 IPGRI 6.2.15
	Very Low (10)		1	
	Low (21-29)		3	
	Medium (36-44)	*	5	
	High (51-59)		7	
	Very High (65)		9	
99	Transversal Ridges on the Side			OIV 244 IPGRI 6.2.16
	Absent	*	0	
	Present		1	

100	Seed Colour			TE7 (Al- wared and al-maidama [22] (Makhoul *et al.*, [5])
	Brown	*	1	
	Grey		2	
	Black		3	
101	The Number of Seeds in a Grape Fruit			TE8 (Al- wared and al-maidama [22] (Makhoul *et al.*, [5])
	1-2		1	
	1-3		2	
	1-4	*	3	
102	Number of Seeds in the Cluster	301.5		TE9 (Al- wared and al-maidama [22] (Makhoul *et al.*, [5])
103	Chalaza Form			TE10 (Al- wared and al-maidama [22] (Makhoul *et al.*, [5])
	Round		1	
	Oval		2	
	Protruding From the Surface of the Seed		3	
	Low Above the Surface of the Seed	*	4	
	Berry (Must)		-	Code
104	Sugar Content of Must (%)			OIV 505 IPGRI 7.1.17
	Low (15 sugar)		1	
	Medium (18 sugar)	*	3	
	High (21 sugar)		5	
	Very High (24 sugar)		7	
105	Total Acid Content of Must (%)			OIV 506 IPGRI 7.1.18
	Very Low (less than 0.4)		1	
	Low (0.4-0.6)	*	3	
	Medium (0.6-0.8)		5	
	High (0.8-1.2)		7	
	Very High (more than 1.2)		9	
106	Yield PH of Must			OIV 508
	Very Low (less than 3.0)		1	
	Low (3.0-3.2)		3	
	Medium (3.2-3.5)		5	
	High (3.5-3.8)	*	7	
	Very High (more than 3.8)		9	