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International Journal of Fruit Science

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/wsfr20

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To cite this article: Pilar Gago, Susana Boso, José Luís Santiago, Jaume-Xavier Soler, Rosa Peiró, Julio García, Carles Jiménez, Carmina Gisbert & María Del Carmen Martínez (2022) Characterization of Grapevine Genetic Resources in the Comunitat Valenciana (Spain), International Journal of Fruit Science, 22:1, 287-302, DOI: 10.1080/15538362.2022.2037039

To link to this article: https://doi.org/10.1080/15538362.2022.2037039

INTERNATIONAL JOURNAL OF FRUIT SCIENCE
2022, VOL. 22, NO. 1, 287–302
https://doi.org/10.1080/15538362.2022.2037039

RESEARCH ARTICLE

Characterization of Grapevine Genetic Resources in the Comunitat Valenciana (Spain)

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ABSTRACT
Grapevine cultivation is of historic importance arround the Mediterranean basin. The Spanish Levant is an area of notable grapevine diversity, where ancient varieties destined for producing wine, table grapes and raisins can still be found. For some of these neglected varieties, however, no complete description has ever been made; current legislation does not, therefore, allow their commercial use. The botanical characterization of old varieties is an important step toward their identification and can also help to clarify synonymies and homonymies, problems very commonly encountered with this crop. The present work provides ampelographic descriptions of seven genotypes for which microsatellite marker profiles were already available, and discusses the possible origins of their names, as well as instances of synonymy and homonymy. Seven accessions of ancient grapevine genotypes from the Spanish Levant were subjected to in situ ampelographic analysis following official methods. The characteristics of their leaves, bunches and berries were recorded. The ampelographic descriptions made in the present work provide insight into the history of cultivation of the examined genotypes and would pave the way for their inclusion in the Spanish national catalog, which would allow their commercial use. The information gathered on the possible origin of these genotypes' names, and instances of synonymy and homonymy, enriches our knowledge of this recovered germplasm. The present results contribute toward our understanding of Europe's grapevine genetic diversity, and highlight the need to conserve it.

KEYWORDS
Ampelography; germplasm characterization; neglected cultivars; grapevine biodiversity; traditional viticulture

Introduction

According to the International Organization of Vine and Wine (OIV), Spain has the largest area under grapevine (*Vitis vinifera* L.) cultivation, and despite the broad grapevine cultivar diversity that is found, just two varieties occupy over 43% of the area given over to viticulture: the white variety Airén, and the red variety Tempranillo. Airén occupies a total 22.3% (217,000 ha) of this surface (International organization of vine and wine, 2017) (it is grown almost exclusively in Spain, especially in the region of Castilla-La Mancha, where it has its origins (Cabello et al., 2011)), and Tempranillo 20.8% (203.000 ha; it is also grown in 17 other countries worldwide) (International organization of vine and wine, 2017). This heavy favoring of a small number of varieties is seen in grapevine-growing areas all over the world; out of an estimated 6000–10000 varieties available (Lacombe et al., 2013; Wolkovich et al., 2018), 33 cover half of all viticultural surface, and just 13 occupy one third of it

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(International organization of vine and wine, 2017). Indeed, minority varieties are suffering serious genetic erosion; many are on the point of disappearing, and many others may have already disappeared. Locating and describing the minority cultivars still available is vital if the traits they carry – which may be important in future breeding programs – and their agricultural potential are to be understood and conserved.

Interest has grown in minority varieties over recent decades; indeed, much effort has been invested in describing Europe's grapevine diversity (Augusto et al., 2021; Crespan et al., 2021; V. Maraš et al., 2015, 2020; Marsal et al., 2017; Martín et al., 2011; Popescu et al., 2015). However, minority varieties continue to be discovered in local (and sometimes neglected) vineyards. Located materials need to be described, conserved, and added to official lists since their absence in national catalogs limits their commercial use. Nevertheless, projects such as the "Rare Traditional Varieties On-Farm" initiative (E. Maul et al., 2019) exist with the aim of potentiating their *in situ* conservation (Biasi and Brunori, 2015). With grapevines, however, it is important to resolve problems of synonymy and homonymy; the same variety can often go by different names, and different varieties often receive the same name (Erika Maul and Töpfer, 2015).

In Spain's Comunitat Valenciana (in the Spanish Levant), viticulture has been of great importance since antiquity; amply attested by evidence at different archeological sites (Gómez-Bellard et al., 1993; Martínez-Valle, 2014). In the 15th century, Alicante's wines were already internationally known and exported to Flanders and England (Piqueras, 2000). The production of table grapes and grapes for raisin production was also very important until the mid-20th century, with 8056 ha and 12,290 ha given over to this activity in the Provinces of Alicante and Valencia, respectively (Ministerio de Agricultura, 1947). Quality table grapes are, indeed, still grown here today; and even there is a Protected Denomination of Origin (PDO) for table grapes called "Uva de Mesa Embolsada del Vinalopó." The area is also home to other three PDO for winemaking areas: Vinos de Alicante, Valencia, and Utiel Requena.

Over the last few years, a number of attempts have been made to locate, identify and conserve the ancient varieties of the Comunitat Valenciana which are nowadays found in very great minority in local vineyards and at serious risk of disappearing(García et al., 2020; Gisbert et al., 2018; Jiménez et al., 2019). Representatives have been found of different varieties that were present in the area before the arrival of phylloxera, and that have unique single sequence repeat (SSR) profiles corresponding to no variety recorded in the Vitis International Variety Catalog international (VIVC) (Erika Maul and Töpfer, 2015), except for two Morsí plants that were found in the same locality in the Province of Alicante and which has the same SSR profile as Sbaa Tolba (Jiménez et al., 2019). Thanks to these research works (García et al., 2020; Gisbert et al., 2018; Jiménez et al., 2019) they have been now added to the VIVC catalog. Some of these varieties were used (Dirección General de Agricultura, 1891), and may still be of interest in winemaking and the production of table grapes. Until now, however, this material has not been described ampelographically. The present work fills this gap. This is a necessary step in gaining official recognition of these varieties in Spain and the European Union.

Materials and methods

Plant Material

Ampelographic analyses of adult leaves, bunches and berries were performed for seven varieties (Esclafagerres, Macabeo Negro, Mamella de Vaca, Mondragón, Montalbana, Morsí and Trepadell) located and/or identified (by SSR amplification) in previous works by Gisbert et al. (2018) and Jiménez et al. (2019). For each of these varieties (hereafter referred to as genotypes), in situ ampelographic observations were made for two growing seasons (2019–2020). These materials were found growing in Benissa (genotypes Trepadell, Macabeo Negro, Montalbana), Monforte del Cid (Morsí), La Mata (Esclafagerres) and Viver (Mondragón) (Figure 1).

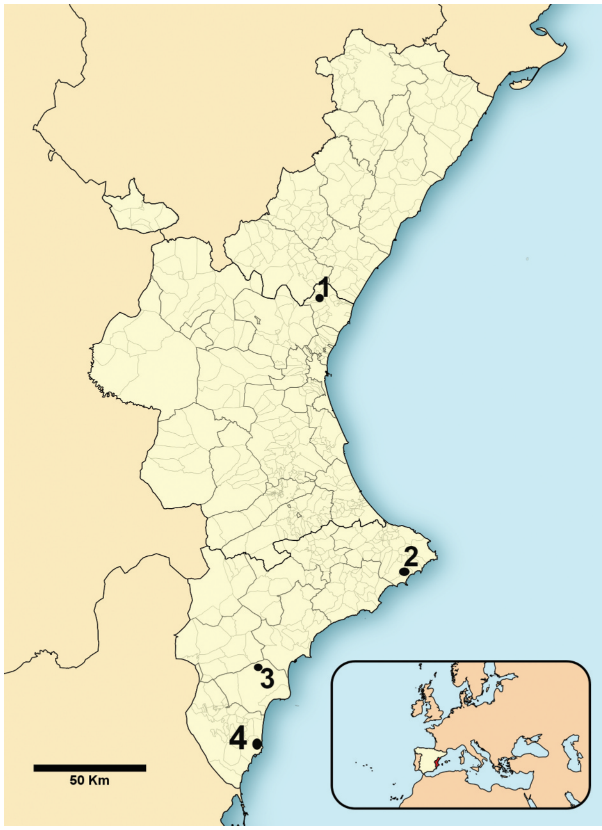

Figure 1. Geographic locations in the Comunitat Valenciana where the genotypes were collected: 1- Viver (Mondragón), 2-Benissa (Trepadell, Macabeo Negro, Montalbana), 3-Monforte del Cid (Morsí) and 4 La Mata (Esclafagerres) .

Ampelographic Characterization of Adult Leaves

Between fruit set and veraison, 10–11 fully expanded leaves (from nodes 8–9 of green shoots produced by the current year's wood) were collected from each accession. These leaves were then pressed and stored dry until use. Leaf qualitative descriptors were noted according to the primary descriptor for mature leaves in the OIV priority list (International Organisation of Vine and Wine, 2009). Eight characteristics were analyzed for each leaf: OIV-067, OIV-068, OIV-070, OIV-076, OIV-079, OIV-081-2, OIV-084, and OIV-087 (Table 1). The modal value for each descriptor was selected as the final result. A digital photograph of each pressed leaf was then taken, and, using ImageJ software (http://rsbweb.nih.gov/ij/), the lengths and angles proposed by Martinez and Grenan (1999) were recorded. The following relationships were then calculated with the measurements made (Figure 2): Rel.2 = L1d/L; Rel.3 = L1g/L; Rel.4 = L2d/L; Rel.5 = L2g/L; Rel.6 = S1d/L1d; Rel.7 = S1g/L1g; Rel.8 = S2d/L2d; Rel.9 = S2g/L2g; Rel.10 = A + B + G; Rel.11 = A' + B' +G'; Rel.12 = a + b + g; Rel.13 = a' + b' + g'; Rel.14 = (S1d + S2d)/(L1d + L2d);Rel.15 = (S1g + S2g)/(L1g + L2g).

Ampelographic Characterization of Bunches and Berries

The characteristics of the bunches and berries of each grapevine variety were recorded following the OIV list of descriptors (International Organisation of Vine and Wine, 2009). According to the OIV definition norms (International Organisation of Vine and Wine, 2009), 5–8 bunches were measured and characterized when mature and eight characteristics were analyzed for each bunch: OIV-202, OIV-

Table 1. Primary descriptors proposed by the OIV (OIV 2009) describing the adult leaves of the studied genotypes. Mode values.

		GENOTYPE						
DESCRIPTOR	OIV CODE	Esclafagerres	Macabeo Negro	Mamella de Vaca	Mondragón	Montalbana	Morsí	Trepadell
Mature leaf: shape of blade	OIV 067	4-Circular	3-Pentagonal	3-Pentagonal/ 4-Circular	3-Pentagonal/ 4-Circular	4-Circular	3-Pentagonal/ 4-Circular	3-Pentagonal
Mature leaf: number of lobes	OIV 068	3- Five	2- Three	3- Five	3- Five	3- Five	3- Five/5-Seven	5-Seven
Mature leaf: area of anthocyanin coloration of main veins on upper side of blade	OIV 070	3-up to the 1st bifurcation	2-Only at the petiolar point	3-up to the 1st bifurcation	1- Absent	3-up to the 1st bifurcation	3-up to the 1st bifurcation	1- Absent
Mature leaf: shape of teeth	OIV 076	5-mixture between straight and convex	2- both sides straight	3-Both sides convex	2- both sides straight	3-Both sides convex	5-mixture between straight and convex	4-one side concave, one side convex
Mature leaf: degree of opening/overlapping of petiole sinus	OIV 079	7-overlapped	3-Open	3-Open/ 5-Closed	3-Open	3-Open	9-strongly overlapped	3-Open
Mature leaf: petiole sinus base limited by veins	OIV 081–2	1- Not limited	1- Not limited	1- Not limited	1- Not limited	1- Not limited	1- Not limited	1- Not limited
Mature leaf: density of prostrate hairs between main veins on lower side of blade	OIV 084	5- Medium	5- Medium	1-None or very low	5- Medium	7-High	5-Medium	3-Low
Mature leaf: density of erect hairs on main veins on lower side of blade	OIV 087	1-None or very low	1-None or very low	1-None or very low	3-Low	1-None or very low	5-Medium	5-Medium

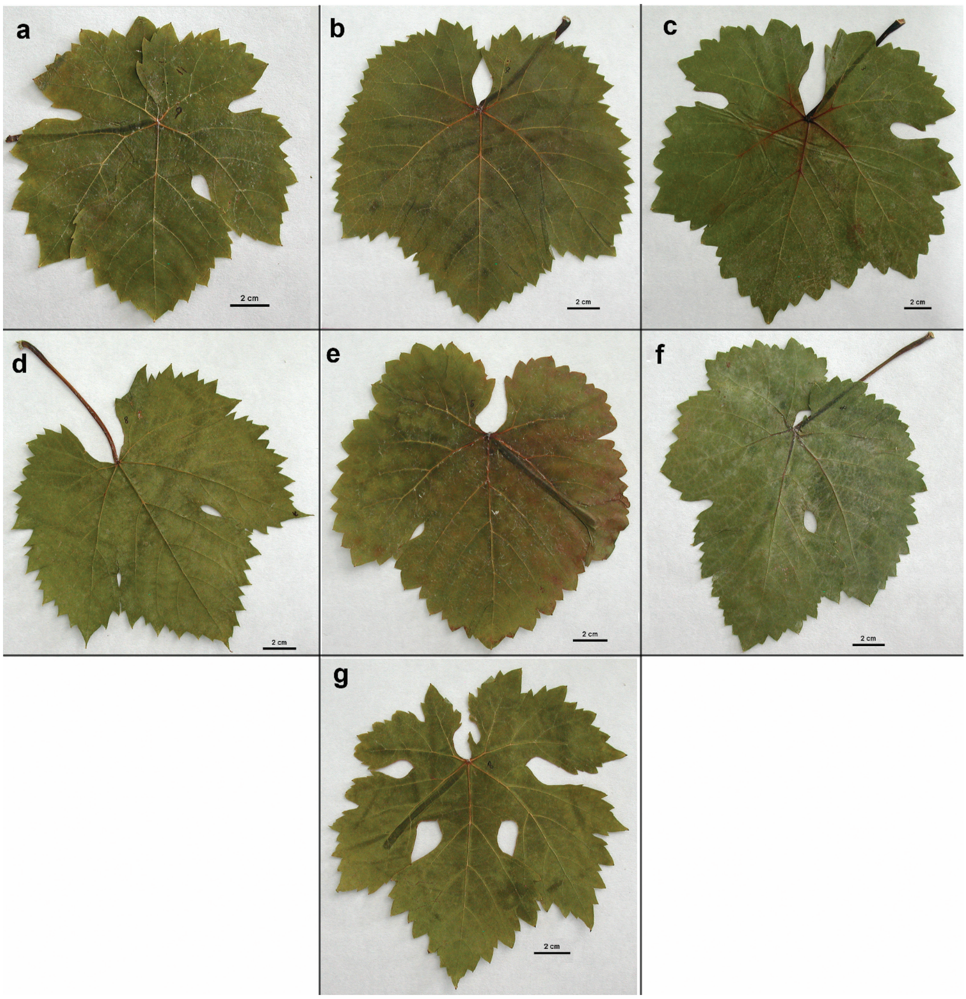

Figure 2. Morphology of the adult leaves. A: Esclafagerres; B: Macabeo Negro; C: Mamella de Vaca; D: Mondragón; E: Montalbana; F: Morsí. G: Trepadell. Scale bar = 2 cm.

203, OIV-204, OIV-206, OIV-208, OIV-209, OIV-502 and number of berries per bunch (Tables 2 and 3). Berry characteristics were noted for 30 non-deformed and normally sized berries taken from the middle part of the bunches, a total of 19 characteristics were analyzed for the berries: OIV-220, OIV-221, OIV-222, OIV-223, OIV-225, OIV-226, OIV-227, OIV-229, OIV-231, OIV-232, OIV-235, OIV-236, OIV-238, OIV-240, OIV-241, OIV-242, OIV-243, OIV-503 and number of seeds (Tables 3 and 4). The modal value for each descriptor for bunches and berries was selected as the final result. After the notation, the berries were then opened and the seeds extracted; 30 well developed seeds were then dried to constant weight in a stove at 35°C and afterward their length and weight were recorded.

Statistical Analysis

In order to avoid errors from data of ampelographic characterization referred to plants grown into different environments, principal component analysis (PCA) was performed using only the calculated relationships described above for mature leaf measured parameters. This will allow to summarize and more easily visualize the dataset. All data were analyzed using the SAS System v.9.3 software package (SAS Institute, Cary, NC, USA).

Results

Ampelographic Characterization of Adult Leaves

Supplementary Table S2 shows the results for the relationships calculated from the different leaf lengths and angles. Table 1 summarizes the ampelographic description of the adult leaves of each genotype.

Some of the genotypes had clearly different leaves characteristics (Table 1 and Figure 2). For example, Esclafagerres´ leaves had a strongly overlaid petiole sinus; the Mamella de Vaca leaves were very large; Macabeo Negro´s leaves had teeth with both sides straight and no upright hairs on the veins, although they were present between the veins and were very long (data not shown); Mondragón´s leaves had teeth with both sides straight; leaves in genotype Montalbana had prostrate hairs (that tended to fall off) on the upper side of the leaf; in genotype Morsí the leaves had large and notably pale green leaves, teeth in the petiole sinus (not always) and upper lateral sinuses (not always), a strongly overlaid petiole sinus, a medium density of prostrate hairs between the main nerves on the lower leaf surface, and upright hairs on those nerves; and Trepadell´s leaves had deep, open lateral sinuses, sometimes containing a tooth.

PCA performed using the relationships calculated from the leaf measurements and angles recorded (Suppl. Table S2) showed the first two axes to account for 84.21% of the total variance, and the first three to account for 94.02% (Suppl. Table S3). The variables with the most weight associated with the first axis (prin1) were Rel.6, Rel.7, Rel.8, Rel.9, Rel.14 and Rel.15, all of which are related to the depth of the upper and lower lateral sinuses (Suppl. Table S3). The variables with the most positive weight associated with prin2 were Rel.10, Rel.11, Rel.12 and Rel.13, all of which refer to the angles formed by the main veins; those with the most negative weight were Rel.2, Rel.3, Rel.4 and Rel.5, all related to the shape of the leaf. The variables with the most positive weight associated with prin3 were Rel.3 and Rel.5, which refer to the shape of the left side of the leaf; that with the most negative weight was Rel.2, which refers to the relationship between L1d and the main vein.

In the diagram obtained using the first three PCA axes (Figure 3), the genotypes with very small lateral sinuses (e.g., Macabeo Negro and Montalbana) cluster to the left with respect to prin1; those with deep lateral sinuses (such as Trepadell and Esclafagerres) cluster toward the right. The genotypes with leaves showing the largest sum values of their angles (particularly Morsí) appear toward the upper part of the diagram with respect to prin2, while those with the smallest (Trepadell and Mondragón) appear toward the bottom. With respect to prin3, the genotypes with the smallest Rel 3 and Rel 5 and largest Rel 2 values (Morsí and Trepadell), which are characterized by their asymmetric leaves in which the nerves L1 and L2 on the left side are smaller than those on the right, gather toward the front of the diagram. Esclafagerres and Mamella de Vaca, with their more symmetrical leaves, appear toward the back.

Ampelographic Characterization of Bunches and Berries

Table 2 shows the results for the bunch quantitative variables, and Table 3 reports the qualitative descriptors. Trepadell had the largest and heaviest bunches, while Macabeo Negro had the smallest and lightest. Those of Mondragón were often cylindrical whereas all other genotypes had conical bunches (Figure 4). Morsí had the least compact bunches, and Macabeo Negro the most tightly packed bunches. All the genotypes had bunches with 1–2 wings (Figure 4).

Table 3 also reports the qualitative descriptors recorded for the berries, while Table 4 shows the values for their measured quantitative variables. All the genotypes had berries of a uniform size throughout their bunches (Figure 5), and all had almost spherical berries (Figure 6) except for Macabeo Negro which had flattened spherical and inverse ovoid berries, and Trepadell which had short, elliptical berries. Berry color varied (Table 3); Mamella de Vaca had non-uniform pink berries, Montalbana had berries with a red epidermis, Esclafagerres, Morsí and Trepadell had yellow-green berries, and those of Macabeo Negro and Mondragón were blue-black. The berries of all the genotypes showed a medium level of bloom, except for Macabeo Negro, which showed a high level of bloom

Table 2. Quantitative ampelographic data for the bunches of each genotype.

GENOTYPE		Bunch length (mm) OIV 202	Bunch width (mm) OIV 203	Length of peduncle (mm) OIV 206	Bunch weight (g) OIV 502	Number of berries per bunch
Esclafagerres	M*	200.07	112.65	30.35	582.6	190.0
	SD	24.13	27.86	9.46	127.0	41.8
	CV	12.06	24.73	31.17	21.8	22.0
	Note OIV	Long	Narrow/ Medium	Very Short	Medium	
Macabeo Negro	M	111.98	70.91	23.25	146.7	150.0
	SD	10.42	18.55	10.93	29.3	0.0
	CV	9.31	26.17	47.03	19.9	0.0
	Note OIV	Short	Narrow	Very short	Very low	
Mamella de Vaca	M	173.6	136.3	29.1	521.3	187.5
	SD	43.4	12.1	5.0	81.2	58.2
	CV	25.0	8.9	17.0	15.6	31.1
	Note OIV	Medium	Medium	Very Short	Medium	
Mondragón	M	197.36	74.80	37.85	328.7	170.0
	SD	21.78	11.38	11.59	88.5	27.4
	CV	11.04	15.22	30.63	26.9	16.1
	Note OIV	Long	Narrow	Very short	Low	
Montalbana	M	135.83	110.74	20.14	339.5	190.0
	SD	27.68	22.22	4.84	117.7	41.8
	CV	20.38	20.06	24.01	34.7	22.0
	Note OIV	Short	Narrow/ Medium	Very short	Low	
Morsí	M	204.43	137.60	61.93	591.9	170.0
	SD	28.37	32.89	4.32	284.7	44.7
	CV	13.88	23.90	6.98	48.1	26.3
	Note OIV	Long	Medium	Short	Medium	
Trepadell	M	235.71	153.34	39.79	711.5	210.0
	SD	22.66	24.63	5.69	207.6	22.4
	CV	9.61	16.06	14.30	29.2	10.6
	Note OIV	Very long	Wide	Very short	High	

*M-mean, SD-standard deviation, CV-coefficient of variance.

accorfing to the OIV-227 characteristic. The berries of Mamella de Vaca and Macabeo Negro had a patent hilum. The berry pulp of all the genotypes was juicy; none had any notably different flavor. The pulp of Esclafagerres, Mondragón and Morsí berries was soft, while that of Mamella de Vaca, Macabeo Negro, Montalbana and Trepadell was firm. The berry epidermis was thin in Mondragón, Morsí and Trepadell, but thick and with a bitter taste in the remaining genotypes (data no shown). Finally, the seeds of all the genotypes were well formed (Table 3 and Figure 6). Those of Montalbana were the smallest and lightest, and those of Mamella de Vaca the largest and heaviest.

Discussion

With the exception of Macabeo Negro, references exist to the prior cultivation of varieties with the same names as the present material before the arrival of phylloxera in this region in 1912 (Piqueras, 2005). For example, in the 19th century, Esclafagerres, Mamella de Vaca, Mondragón, Montalbana and Trepadell were names mentioned by the Dirección General de Agricultura, Industria y Comercio (Dirección General de Agricultura, Industria y Comercio, 1891); Esclafagerres (written as "Esclafacherris"), Montalbana and Morsí appear in an ancient book from 1885 (Abela y Sainz de Andino, 1885); and Montalbana (written as "Muntalbana") appears in the famous 15th century manuscript book Llibre de l'Espill ("Book of the Mirror") written by Jaume Roi which is one of the

Table 3. Qualitative descriptors recorded for the morphological characterization of bunches and berries (International Organisation of Vine and Wine, 2009). Mode values.

		GENOTYPE						
	OIV CODE	Esclafagerres	Macabeo Negro	Mamella de Vaca	Mondragón	Montalbana	Morsí	Trepadell
BUNCH DESCRIPTORS								
Density	OIV (204)	(7) dense	(9) very dense	(5)medium	(5–7) medium/dense	(7–9) dense/very dense	(3) loose	(7) dense
Shape	OIV (208)	(2) conical	(2) conical	(2) conical	(1–2) cylindrical/ conical	(2) conical	(2) conical	(2) conical
Number of wings of the primary bunch	OIV (209)	(2) 1–2 wings	(2) 1–2 wings	(2) 1–2 wings	(2) 1–2 wings	(2) 1–2 wings	(2) 1–2 wings	(2) 1–2 wings
BERRY DESCRIPTORS								
Uniformity of size	OIV (222)	(2) uniform	(2) uniform	(2) uniform	(2) uniform	(2) uniform	(2) uniform	(2) uniform
Shape*	OIV (223)	(2) globose	(1–8) globose / obovoid	(2) globose	(2–3) globose/ broad ellipsoid	(2) globose	(2) globose	(3) broad elipsoid
Color of skin*	OIV (225)	(1) green yellow	(6) blue black	(2) rose	(6) blue black	(5) dark red violet	(1) green yellow	(1) green yellow
Uniformity of skin color	OIV (226)	(2) uniform	(2) uniform	(1) no uniform	(2) uniform	(2) uniform	(2) uniform	(2) uniform
Bloom	OIV (227)	(5) medium	(7) high	(5) medium	(5) medium	(5) medium	(5) medium	(5) medium
Hilum	OIV (229)	(1) little visible	(2) visible	(2) visible	(1) little visible	(1) little visible	(1) little visible	(1) little visible
Intensity of flesh anthocyanin coloration	OIV (231)	(1) none or very weak	(1) none or very weak	(1) none or very weak	(1) none or very weak	(1) none or very weak	(1) none or very weak	(1) none or very weak
Juiciness of flesh	OIV (232)	(3) very juicy	(2) medium juicy	(3) very juicy	(3) very juicy	(2–3) medium /very juicy	(3) very juicy	(2) medium juicy
Firmness of flesh	OIV (235)	(1) soft	(2) slightly firm	(2) slightly firm	(1) soft	(2) slightly firm	(1) soft	(2) slightly firm
Particular flavor	OIV (236)	(1) none	(1) none	(1) none	(1) none	(1) none	(1) none	(1) none
Ease of detachment from pedicel	OIV (240)	(2) easy	(3) difficult	(2) easy	(2) easy	(2) easy	(2) easy	(3) difficult
Formation of seeds	OIV (241)	(3) Complete	(3) Complete	(3) Complete	(3) Complete	(3) Complete	(3) Complete	(3) Complete

Table 4. Quantitative ampelographic characteristics of the berries produced by the studied genotypes.

GENOTYPE		Berry length (mm) OIV 220	Berry width (mm) OIV 221	Length of pedicel (mm) OIV 238	Number of seeds	Length of seeds (mm) OIV 242	Weight of seeds (mg) OIV 243	Berry Weight (g) OIV 503
Esclafagerres	M*	18.91	18.03	7.97	1.87	6.15	29.07	3.82
	D.S.	1.48	1.31	1.07	0.73	0.42	7.53	0.79
	CV	7.81	7.24	13.38	39.12	6.80	25.913	20.67
	Note OIV	Medium	Medium	Short		Medium	Low-Medium	Low
Macabeo Negro	M	13.53	14.30	4.94	1.82	5.84	31.64	1.73
	D.S.	1.18	1.28	1.05	0.77	0.36	4.94	0.36
	CV	8.69	8.95	21.23	42.39	6.16	15.613	20.59
	Note OIV	Short	Narrow	Very Short		Medium	Low-Medium	Very Low
Mamella de Vaca	M	18.36	19.09	7.18	2.38	6.72	34.60	4.37
	D.S.	1.72	1.76	1.43	0.74	0.33	6.53	1.33
	CV	9.38	9.20	19.87	30.99	4.91	18.859	30.46
	Note OIV	Medium	Medium	Short		Long	Low-Medium	Low/Medium
Mondragón	M	17.16	16.30	5.95	2.42	6.56	31.40	3.03
	D.S.	1.84	2.28	0.91	0.83	0.57	4.940	0.90
	CV	10.70	14.01	15.37	34.32	8.74	11.765	29.55
	Note OIV	Medium	Narrow	Short		Medium	Low-Medium	Low
Montalbana	M	13.85	15.66	5.64	2.43	4.97	17.66	2.18
	D.S.	1.39	1.40	1.00	0.91	0.31	3.63	0.59
	C.V.	10.06	8.95	17.75	37.35	6.16	20.545	27.28
	Note OIV	Short	Narrow	Short		Short	Very low-Low	Low
Morsí	M	17.43	17.19	6.10	1.13	5.71	28.73	3.45
	D.S.	1.47	1.32	1.03	0.35	0.38	4.62	0.72
	CV	8.44	7.65	16.87	30.51	6.61	16.064	20.91
	Note OIV	Medium	Narrow	Short		Medium	Low	Low
Trepadell	M	18.92	16.61	6.61	1.30	5.95	27.87	3.32
	D.S.	1.19	1.18	0.91	0.53	0.36	3.78	0.60
	CV	6.31	7.13	13.76	41.15	6.01	13.550	18.02
	Note OIV	Medium	Narrow	Short		Medium	Low	Low

**M-mean, SD-standard deviation, CV-coefficient of variance.*

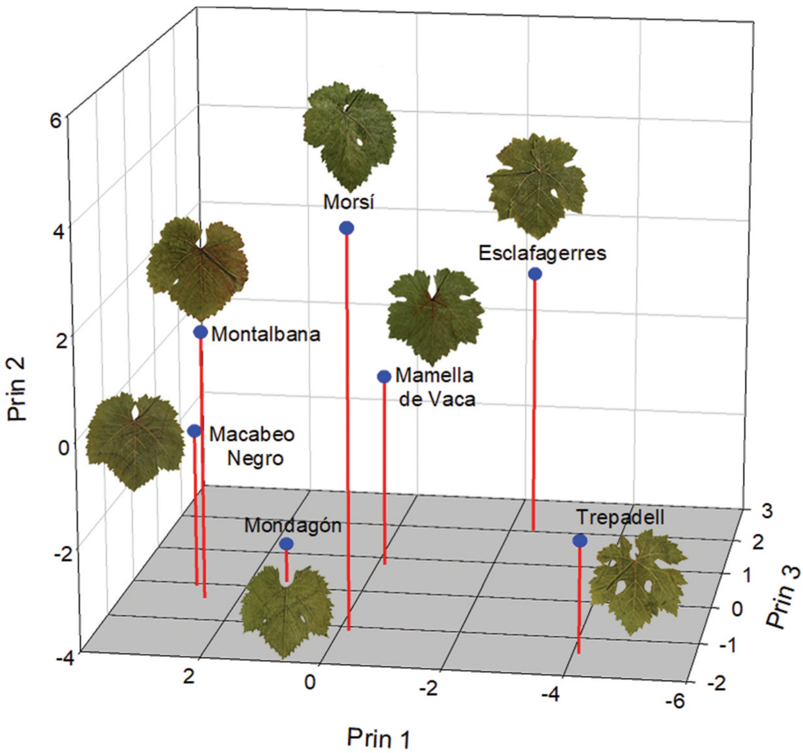

Figure 3. PCA results, showing the distribution of the genotypes in terms of their typical adult leaves with respect to the first three axes (prin1, Prin2 and Prin3) .

great works of medieval literature in Valencian language. In Cabello et al. (2011), Mondragón is mentioned as a native minority cultivar; it is also cited by García de Los Salmones (1914) as being cultivated in the Province of Castellón.

According to Viard (1892), the Romans made their best wine from vines cultivated in the Mondragone Hills in Campania (Italy), and the name of the present Mondragón genotype may have its roots in this, but nevertheless Mondragón is an offspring of Marufo x Monastrell (D'Onofrio et al., 2021) and Marufo is a putative Portuguese variety with female flowers and that bears chlorotype D, with a major role in the development of cultivars in the Iberian Peninsula (Cunha et al., 2020); therefore, the Italian origin for this cultivar name seems unlikely. Also, according to Favà (2001), the origin of the name Montalbana may lie in a Tuscan wine known as Montalbano made in the Montalbano Hills area of Pistoia. The name Esclafagerres comes from the Valencian words "esclafar" meaning to squash, and "gerres" meaning clay wine vats. The name might therefore be 'equivalent' to the names Quebrantatinajas, Rompetinajas or Revientatinajas in Castilian Spanish (meaning vat-cracker, vat-breaker, and vat-ripper, respectively). However, the microsatellite profile of Esclafagerres (Gisbert et al., 2018) does not coincide with that of any of these other varieties, which in any event are recorded as having red- or black-skinned berries, not green-yellow like those of Esclafagerres. According to local growers, Esclafagerres was not a good winemaking variety, but was used alongside others, such as Merseguera, to reduce the final alcohol content – a characteristic appreciated in the area since the high temperatures cause the grapes to accumulate large amounts of sugar that becomes converted into alcohol during fermentation.

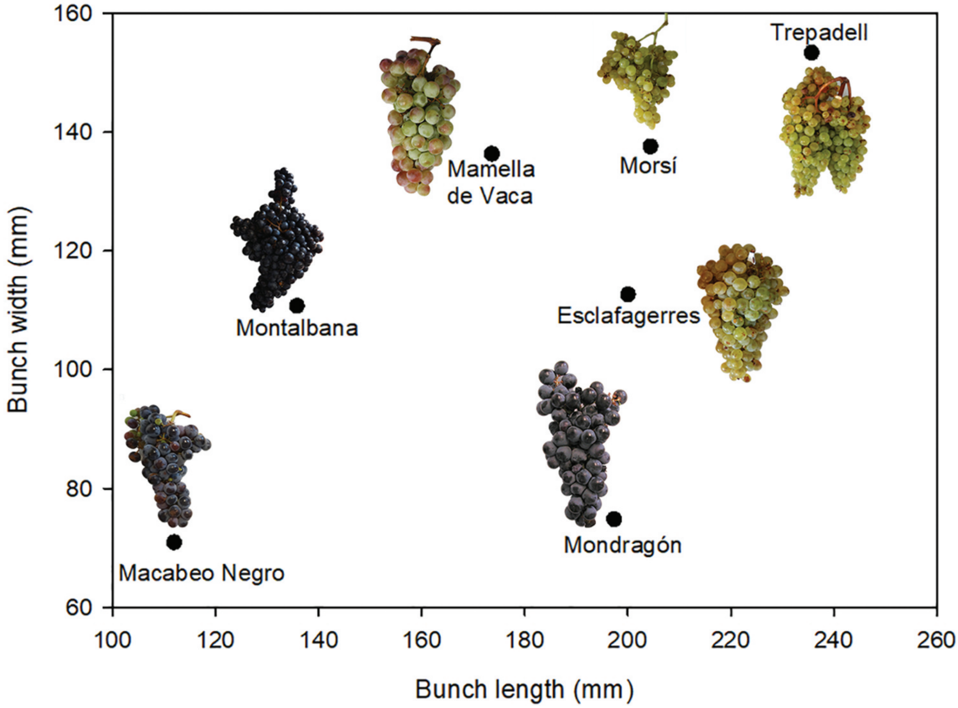

Figure 4. Distribution of bunch characteristics with respect to length and width (mean values)

No historic reference was found for any variety with the name of Macabeo Negro – the name given known by the grower on whose vineyard the single accession of this genotype was discovered (in El Pinoso, Province of Alicante). The SSR profile (Jiménez et al., 2019) of Macabeo Negro indicates it to be quite unlike the well known variety Macabeo, also, these two genotypes have different ampelographic characteristics, fr instance, Macabeo Negro has blue-black berries and short bunches, while Macabeo has yellow berries and medium-to-large bunches.

Macabeo Negro, Montalbana and Mondragón are strongly related, all three have blackish berries and are of chlorotype D andtheir SSR profiles indicated that they could all be hybrids of the variety Crujidera (synonymous with the Portuguese variety Marufo, has female flowers and belongs to chlorotype D), and Monastrell (the most grown variety in the Province of Alicante) (Jiménez et al., 2019). The three varieties are distinguished in that Macabeo Negro has virtually no lateral sinuses leaving it with 'entire' leaves, more compact bunches, and its berries are not uniform in shape throughout the bunch. Montalbana, in contrast, is distinguished by the red-violet color of its berries, and the small size of its seeds. Finally, the pulp of Mondragón berries is softer than that of the other two genotypes (Figures 3 and 6).

Among the white genotypes, Esclafagerres and Trepadell have bigger and more compact bunches than Morsí, but all coincide in their conical shape and the presence of wings. In addition, Morsí has bunches of variable weight (CV = 48.1%) which could be related to the tendency of some table grape varieties to show millerandage (Ibáñez et al., 2020). Thus, in some years the bunches may be uniform in weight, and in others vary variable. Esclafagerres and Trepadell belong to chlorotype A (Jiménez et al., 2019), as do 75% of all varieties from Spain and Portugal (Arroyo-García et al., 2016; Castro et al., 2011). Morsí, however, belongs to chlorotype C and has the same SSR profile as Sbaa Tolba, which is recorded in the VIVC database as originating in Algeria. Morsí and Sbaa Tolba are therefore synonyms (García et al., 2020; Jiménez et al., 2019). Galet (2000) cites Sbaa Tolba as a white table grape variety from Morocco, and Laiadi et al. (2009) suggest it may be found in different parts of the Maghreb and that it

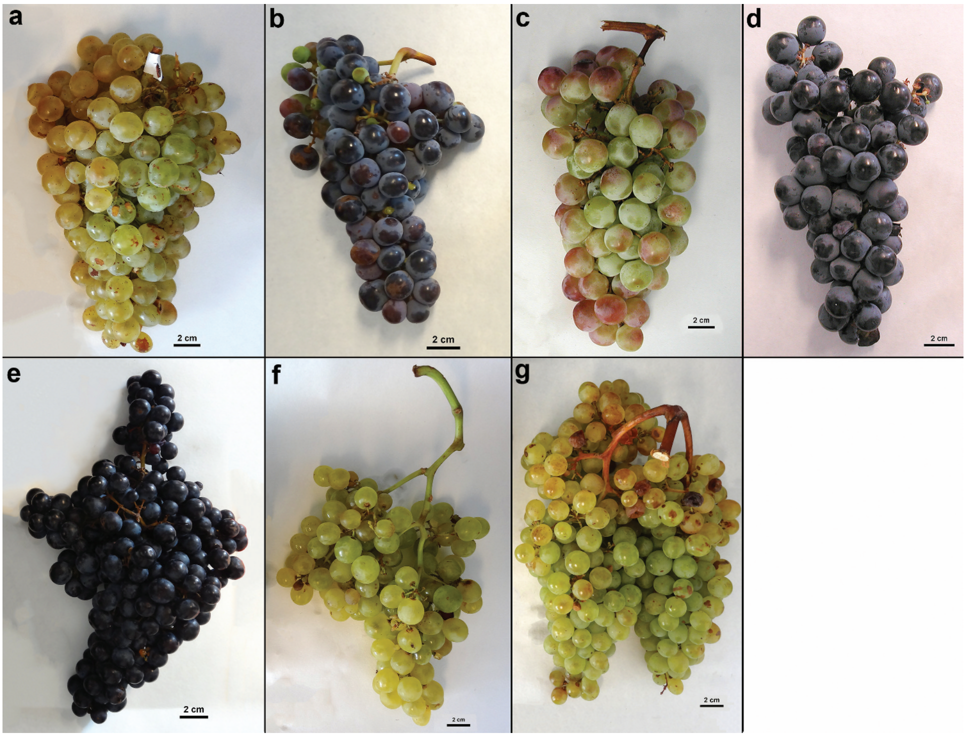

Figure 5. Bunch morphology. A: Esclafagerres; B: Macabeo Negro; C: Mamella de Vaca; D: Mondragón; E: Montalbana; F: Morsí. G: Trepadell. Scale bar = 2 cm.

might be related to Sultanina, with which it shares the C chlorotype. This chlorotype indicates a possible origin in the Near East/North Africa (Arroyo-García et al., 2016). In an ampelographic and molecular analysis of Algerian genotypes, Zinelabidine et al. (2014) reported an analyzed accession under the name of Sbaa Tolba (from the M'zej Edchiche Institut Téchnique d'Arboriculture Fruitière (ITAF) grape collection in Algeria) to have the same profile as Planta Fina (an accession held in the IMIDRA collection (Martín et al., 2003)). The SSR profile of this last accession coincides with that for Planta Fina in the VIVC database, and with those reported for this same genotype by García et al. (2020) and Jiménez et al. (2019). In addition, the foliar morphology presented in Zinelabidine et al. (2014) for the accession in the ITAF does not match with that of Morsí (synonym Sbaa Tolba), for example the petiole of the first is clearly open while in Morsí is strongly overlapped.Thus, the accession stored as "Sbaa Tolba" in the ITAF from Zinelabidine et al. (2014) is a case of misnaming.

Finally, Mamella de Vaca is differentiated by its non-uniform pink berries. (Jiménez et al., 2019) detected the same SSR profile in accessions collected from the area but with no name, in an accession that was said to belong to the variety Cambril – an identification rejected since Cambril is an early ripening variety (Favà, 2001) – and in an accession collected under the name of Mamella de Vaca. All these materials were named as "Mamella de Vaca" by Jiménez et al. (2019). Plants with the same profile were later found under the name Roget Tardà and Raïm de Tot Sants (García et al., 2020). Unfortunately, the name Mamella de Vaca has also been given to other varieties. For example, the variety Ahmeur bou Ahmeur has also been found under this name. Ahmeur bou Ahmeur is a widespread table grape variety from North Africa (Galet, 2000) with "rouge" berries and, to complicate matters, many synonyms (Zinelabidine et al., 2014), including the Castilian Spanish name "Teta de Vaca" (cow teat) which is linguistically equivalent to Mamella de Vaca despite it not actually being the same variety (Cabello et al., 2011; Clemente, 1807; Martín et al., 2003). To

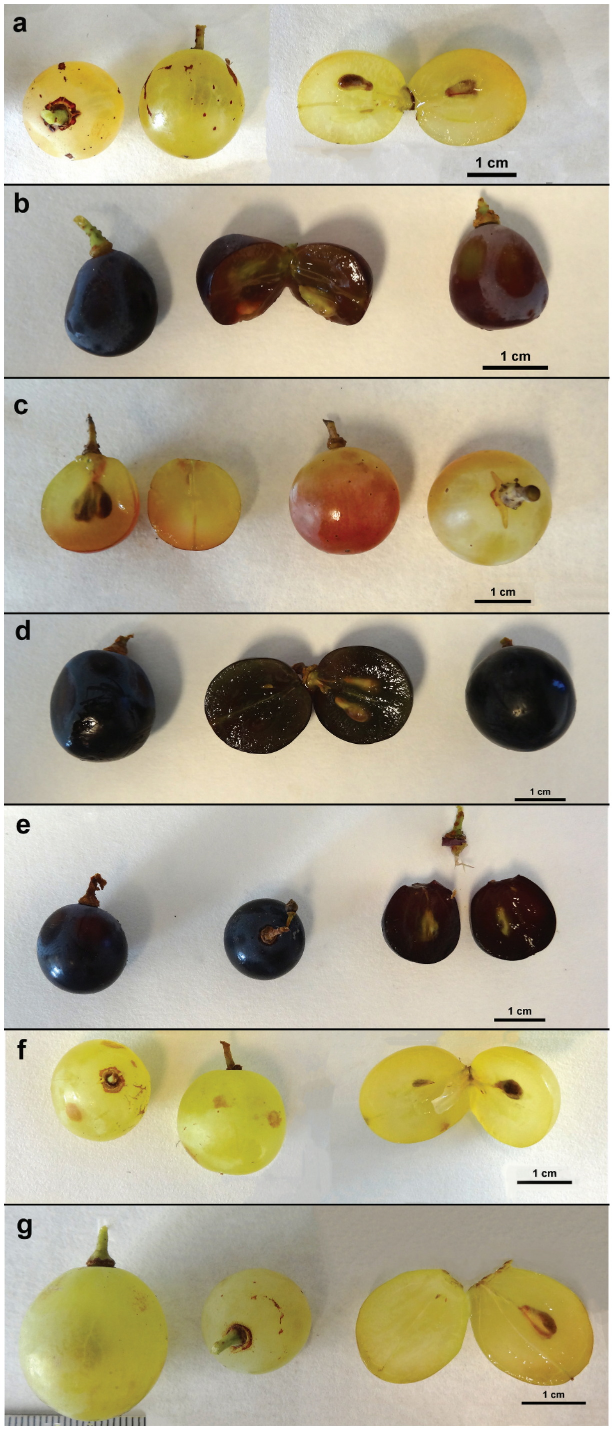

Figure 6. Berry morphology. A: Esclafagerres; B: Macabeo Negro; C: Mamella de Vaca; D: Mondragón; E: Montalbana; F: Morsí. G: Trepadell. Scale bar = 1 cm.

complicate things even further, in the Comunitat Valenciana, Ahmeur bou Ahmeur is known as Botó de Gall (García et al., 2020). Although Jiménez et al. (2019) originally called the accessions they examined by the name Mamella de Vaca, it might be better to reduce confusion by using the synonym Roget Tardà (García et al., 2020); this means 'late red' in the Valencian language, which describes the berry color and the ripening time very well.

Conclusions

The ampelographic descriptions of the studied genotypes made in the present work pave the way for their inclusion in the Spanish national catalog, which would allow for their commercial use. The information gathered on the possible origin of their names, and the recognition of synonymies and homonymies, enriches our knowledge of the recovered germplasm and of Europe's viticultural heritage as a whole. A program has begun to conserve these genotypes and their contribution to grapevine diversity.

Acknowledgments

The varieties characterized in this work were recovered/identified within the framework of projects CGL2015-70843-R and 2020/VALORIZA/VSC/015, funded by MINECO and GVA, respectively. The authors thank C. Chirivella and A. Yuste for helping in the recovery of varieties. E. Zubiaurre, I. Gozález and J. M. Lalín are thanked for technical assistance. The English version of the manuscript was prepared by Adrian Burton

Disclosure Statement

No potential conflict of interest was reported by the author(s).

Authorship Declaration

The names of all the co-authors have been included in the manuscript; all are in agreement with the content of this manuscript. All contributed significantly to this original work, which has not been published or submitted for publication elsewhere.

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References

Abela, Y., and E. Sainz de Andino. 1885. El libro del Viticultor. Madrid: Manuel G. Hernández.

Arroyo-García, R., M. Cantos, M. Lara, M.-Á. López, A. Gallardo, C.A. Ocete, Á. Pérez, H. Bánáti, J.L. García, and R. Ocete. 2016. Characterization of the largest relic Eurasian wild grapevine reservoir in Southern Iberian Peninsula. Span. J. Agric. Res. 14(3):e0708. doi: 10.5424/sjar/2016143-8929.

Augusto, D., J. Ibáñez, A.L. Pinto-Sintra, V. Falco, F. Leal, J.M. Martínez-Zapater, A.A. Oliveira, and I. Castro. 2021. Grapevine diversity and genetic relationships in Northeast Portugal Old Vineyards. Plants 10(12):2755. doi: 10.3390/plants10122755.

Biasi, R., and E. Brunori. 2015. The on-farm conservation of grapevine (Vitis vinifera L.) landraces assures the habitat diversity in the viticultural agro-ecosystem. Vitis 54(Special Issue):265–269.

Cabello, F., J.M. Ortiz, G. Muñoz, I. Rodríguez, A. Benito, C. Rubio, S. García, and R. Sáiz. 2011. Variedades de vid en España. Madrid: Agrícola Española.

Castro, I., J.P. Martín, J.M. Ortiz, and O. Pinto-Carnide. 2011. Varietal discrimination and genetic relationships of Vitis vinifera L. cultivars from two major Controlled Appellation (DOC) regions in Portugal. Sci. Hortic. 127(4):507–514. doi: 10.1016/j.scienta.2010.11.018.

Clemente, S.R. 1807. Ensayo sobre las variedades de la vid común que vegetan en Andalucía. Madrid: Imprenta de Villalpando.

Crespan, M., D. Migliaro, S. Larger, M. Pindo, M. Palmisano, A. Manni, E. Manni, E. Polidori, F. Sbaffi, Q. Silvestri, et al. 2021. Grapevine (Vitis vinifera L.) varietal assortment and evolution in the Marche region (central Italy). OENO One. 55(3). doi: 10.20870/oeno-one.2021.55.3.4628.

Cunha, J., J. Ibáñez, M. Teixeira-Santos, J. Brazão, P. Fevereiro, J.M. Martínez-Zapater, and J.E. Eiras-Dias. 2020. Genetic relationships among portuguese cultivated and wild Vitis vinifera L. Germplasm. Front. Plant Sci. 11. doi: 10.3389/fpls.2020.00127.

D'Onofrio, C., G. Tumino, M. Gardiman, M. Crespan, C. Bignami, L. de Palma, M.G. Barbagallo, M. Muganu, C. Morcia, V. Novello, et al. 2021. Parentage Atlas of Italian grapevine varieties as inferred from SNP genotyping. Front. Plant Sci. 11. doi: 10.3389/fpls.2020.605934.

Dirección General de Agricultura, I. y C. (DGAIC). 1891. Avance Estadístico sobre Cultivo y Producción de la Vid en España Formado por la Junta Consultiva Agronómica. Madrid: Péant e Hijos.

Favà, X. 2001. Diccionari dels noms dels ceps i raïms. L'ampelonimia catalana. Barcelona: Institut d'Estudis Catalans.

Galet, P. 2000. Dictionnaire encyclopédique des cépages. Paris: Hachette.

García de Los Salmones, N. (1914). Estudio general de conjunto de las viníferas españolas. In *Memoria general de las Sesiones del Congreso y Ponencias presentadas. Congreso Nacional de Viticultura celebrado en Pamplona* (pp. 512–534). Pamplona: Imprenta Provincial.

García, J., F. Martínez-Gil, J.X.X. Soler, R. Peiró, F. Martínez-Gil, J.X.X. Soler, C. Jiménez, A. Yuste, C. Xirivella, and C. Gisbert. 2020. Recovering old grapevine varieties. Vitis. 59:101–103. doi: 10.5073/vitis.2020.59.101-10.

Gisbert, C., R. Peiró, T.S. Pedro, A. Olmos, C. Jiménez, and J. García (2018 Recovering Ancient Grapevine Varieties: From Genetic Variability to In Vitro Conservation, A Case Study Grapes and Wines Jordao, Antonia Manuel, and Cosme, Fernanda). . In . Rijeka: IntechOpen. doi:10.5772/intechopen.71133

Gómez-Bellard, C., P. Guérin, E. Díes-Cusí, and G. Pérez-Jordá. 1993. El vino en los inicios de la cultura ibérica. Nuevas excavaciones en L´Alt de Benimaquía, Denia. Revista de Arqueología, Madrid 142:16–26.

Ibáñez, J., E. Baroja, J. Grimplet, and S. Ibáñez. 2020. Cultivated grapevine displays a great diversity for reproductive performance variables. Crop Breed. Genet. Genomics 2(1):e200003. doi: 10.20900/cbgg20200003.

International Organisation of Vine and Wine. 2009. *OIV descriptor list for grape varieties and Vitis species* (Second). https://www.oiv.int/public/medias/2274/code-2e-edition-finale.pdf

International organization of vine and wine. 2017. *Distribution of the world's grapevine varieties*. https://www.oiv.int/public/medias/5888/en-distribution-of-the-worlds-grapevine-varieties.pdf

Jiménez, C., R. Peiró, A. Yuste, J. Garciá, F. Martínez-Gil, and C. Gisbert. 2019. Looking for old grapevine varieties. Vitis J. Grapevine Res. 58(2):59–60. Bundesanstalt fur Zuchtungsforschung an Kulturpflanzen. doi:10.5073/vitis.2019.58.59-60

Lacombe, T., J.M. Boursiquot, V. Laucou, M. Di Vecchi-Staraz, J.P. Péros, and P. This. 2013. Large-scale parentage analysis in an extended set of grapevine cultivars (Vitis vinifera L.). Theor. Appl. Genet. 126(2):401–414. doi: 10.1007/s00122-012-1988-2.

Laiadi, Z., M.M. Bentchikou, G. Bravo, F. Cabello, and J.M. Martínez-Zapater. 2009. Molecular identification and genetic relationships of Algerian grapevine cultivars maintained at the germplasm collection of Skikda (Algeria). Vitis 48 (1):25–32. www.genres.de/vitis/vitis.htm .

Maraš, V., T. Popović, A. Gazivoda, J. Raičević, V. Kodžulović, M. Mugoša, and S. Šućur. 2015. Origin and characterization of Montenegrin grapevine varieties. Vitis 54:135–137.

Maraš, V., J. Tello, A. Gazivoda, M. Mugoša, M. Perišić, J. Raičević, N. Štajner, R. Ocete, V. Božović, T. Popović, et al. 2020. Population genetic analysis in old Montenegrin vineyards reveals ancient ways currently active to generate diversity in Vitis vinifera. Sci Rep 10(1):15000. doi: 10.1038/s41598-020-71918-7.

Marsal, G., J. Bota, A. Martorell, J.M. Canals, F. Zamora, and F. Fort. 2017. Local cultivars of Vitis vinifera L. in Spanish Islands: Balearic Archipelago. Sci. Hortic. 226:122–132. doi: 10.1016/j.scienta.2017.08.021.

Martín, J.P., C. Arranz, I.D. Castro, J. Yuste, J.A. Rubio, O. Pinto-Carnide, and J.M. Ortiz. 2011. Prospection and identification of grapevine varieties cultivated in north Portugal and northwest Spain. Vitis 50(1):29–33. http://www.sivvem.monbyte.com/ .

Martín, J.P., J. Borrego, F. Cabello, and J.M. Ortiz. 2003. Characterization of Spanish grapevine cultivar diversity using sequence-tagged microsatellite site markers. Genome 46(1):10–18. doi: 10.1139/g02-098.

Martínez-Valle, A. 2014. La Solana de las Pilillas y otros testimonios de producción y consumo de vino en la Meseta de Requena-Utiel. Lucentum 33(33):51. doi: 10.14198/LVCENTVM2014.33.04.

Martinez, M.-C., and S. Grenan. 1999. A graphic reconstruction method of an average vine leaf. Agronomie 19 (6):491–507. doi: 10.1051/agro:19990607.

Maul, E., T. Schreiber, F. Carka, J. Cunha, J.E.J. Eiras Dias, M. Gardiman, A. Gazivoda, D. Ivanišević, L. Koop, E. Lipman, et al. 2019. Preservation via utilization: Minor grape cultivars on-farm. Acta Hortic. 1248. doi: 10.17660/ActaHortic.2019.1248.8.

Maul, E., and R. Töpfer (2015). Vitis International Variety Catalogue (V IVC): A cultivar database referenced by genetic profiles and morphology BIO Web of Conferences . , 5, 01009. doi: 10.1051/bioconf/20150501009

Ministerio de Agricultura. 1947. Anuario Estadístico de las Producciones Agrícolas. Madrid: Ministerio de Agricultura, Pesca y Alimentación.

Piqueras, J. 2000. Los vinos valencianos: Desde la antigüedad hasta nuestros días. Valencia: Gules.

Piqueras, J. 2005. La filoxera en España y su difusión espacial: 1878-1926. Cuadernos de Geografía 77:101–136.

Popescu, C.R., L.C. Dejeu, and C. Bejan. 2015. Ampelographic characterization - preliminary results of the nine most appreciated autochthonous Vitis vinifera L. varieties from Romania. Vitis 54:159–162.

Viard, E. 1892. *Tratado general de la vid y de los vinos* (Traducción). Madrid: La Farmacia Moderna.

Wolkovich, E.M., I. García de Cortázar-atauri, I. Morales-Castilla, K.A. Nicholas, and T. Lacombe. 2018. From pinot to xinomavro in the world's future wine-growing regions. Nat. Clim. Change 8(1):29–37. doi: 10.1038/s41558-017-0016-6.

Zinelabidine, L.H., Z. Laiadi, R. Benmehaia, P. Gago, S. Boso, J.L. Santiago, A. Haddioui, J. Ibáñez, J.M. Martínez-Zapater, and M.C. Martínez. 2014. Comparative ampelographic and genetic analysis of grapevine cultivars from Algeria and Morocco. Aust. J. Grape Wine Res. 20(2):324–333. doi: 10.1111/ajgw.12079.