GENETIC DIVERSITY OF A BRAZILIAN WINE GRAPE GERMPLASM COLLECTION BASED ON MORPHOAGRONOMIC TRAITS[1]

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ABSTRACT - The objectives of this study were to evaluate the performance of cultivars, to quantify the variability and to estimate the genetic distances of 66 wine grape accessions in the Grape Germplasm Bank of the EMBRAPA Semi-Arid, in Juazeiro, BA, Brazil, through the characterization of discrete and continuous phenotypic variables. Multivariate statistics, such as, principal components, Tocher's optimization procedure, and the graphic of the distance, were efficient in grouping more similar genotypes, according to their phenotypic characteristics. There was no agreement in the formation of groups between continuous and discrete morpho-agronomic traits, when Tocher's optimization procedure was used. Discrete variables allowed the separation of *Vitis vinifera* and hybrids in different groups. Significant positive correlations were observed between weight, length and width of bunches, and a negative correlation between titratable acidity and TSS/TTA. The major part (84.12%) of the total variation present in the original data was explained by the four principal components. The results revealed little variability between wine grape accessions in the Grape Germplasm Bank of Embrapa Semi-Arid.
Index terms: germplasm, grapevine, grape cultivars, *Vitis* spp., multivariate analysis.

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RESUMO - Os objetivos deste trabalho foram avaliar o comportamento agronômico, quantificar a variabilidade e estimar as distâncias genéticas de 66 acessos de videira destinadas à elaboração de vinhos, presente no Banco de Germoplasma de Videira da EMBRAPA Semiárido, em Juazeiro-BA, Brasil, por meio da caracterização de descritores fenotípicos de variação contínua e discreta. As técnicas multivariadas utilizadas, componentes principais, método de otimização de Tocher e projeção gráfica das distâncias foram eficientes no agrupamento dos genótipos mais similares, de acordo com as suas características fenotípicas. Não houve concordância na formação dos grupos pelo método de otimização de Tocher, quando foram avaliadas características morfoagronômicas de variação contínua e discreta. A utilização de variáveis discretas permitiu a separação de *Vitis vinifera* e híbridos em grupos distintos. Correlações significativas positivas foram observadas entre peso, comprimento e largura de cachos, bem como correlação negativa entre acidez total titulável e relação SST/ATT. 84,12% da variação total presente nos dados originais foram explicados pelos primeiros quatro componentes principais. Os resultados obtidos demonstram que existe pequena variabilidade entre os acessos de uvas para vinho no Banco de Germoplasma da Embrapa Semiárido.
Termos para indexação germoplasma, videira, cultivares, *Vitis* spp., análise multivariada.

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INTRODUCTION

The wine industry in São Francisco River Valley had a great evolution in the recent years, there are now seven wineries installed and the planted area is greater than 800 ha, which produced in 2007, eight million liters of wine, representing 20% of the national production (SEBRAE, 2007).

The tropical wines known as sun wine are characterized by young wines, fruity and aromatic, which quality is recognized in international competitions and in the most traditional and demanding markets.

The grape industry in this region has evolved into a narrow genetic base, as there are few cultivars of a single species, *Vitis vinifera* L.. It is worrying from the point of view of sustainability of the grape and wine industry because they are constantly subjected to a high risk of introducing diseases and pests, for which these cultivars are susceptible, resulting in large losses or even in the destruction of vineyards.

The multivariate techniques in the analysis of quantitative and qualitative characteristics have been applied in viticulture in the evaluation of the diversity of genotypes for resistance to diseases (NASCIMENTO et al., 2006) and for morphological, agronomic and biochemical descriptors (MICHELI et al., 1993; CRAVERO et al., 1994, MATHEOU et al., 1995a, 1995b; BOSELLI et al., 2000; COELHO et al., 2004; BORGES et al., 2008). The molecular characterization of 81% of the accessions of the Embrapa Semi Arid grapevine germplasma bank was performed by Leão et al. (2009), using seven microsatellite markers. The allelic profiles were compared with international databases, allowing the identification of many duplicate accessions, synonyms and name errors, generating a robust database for grape cultivars identification. Borges et al. (2008) analyzed a group of table grapes cultivars of the same germplasma bank by principal components and UPGMA.

The objectives of the present work were to evaluate the performance of cultivars, to quantify variability and to estimate their genetic distances, providing subsidies to guide rational management of the Germplasm Bank of Embrapa Semi-Arid and the cultivars use in grape breeding programs

MATERIAL AND METHODS

Sixty six wine grape accessions from the Grape Germplasm Bank of Embrapa Semi-Arid were evaluated (Table 1) in the Experimental Field Station of Mandacaru, Juazeiro, State of Bahia, with geographical coordinate, 9°24'S, 40°26'W, and 365.5m (altitude). The climate is classified according to Koeppen, as Bswh, which corresponds to the semi-arid hot, with average annual precipitation of 505 mm, annual average relative humidity of 60.7%, annual average temperature, maximum, and minimum, respectively 26.7°C, 32.0°C, and 20.8°C (www.cpatsa.embrapa.br/servicos/dadosmet/cem-anual.html).

The plants were trained in multi-wire vertical trellis and pruned in bilateral cordon. The water was supplied by drip irrigation spaced of 3 x 2m. Average data were obtained from four plants of each accession during the period from 2002 to 2007, which corresponded to four cycles.

Nine morpho-agronomic descriptors of continuous variation and six morpho-agronomic descriptors of discrete variation according to the Ipgri (1997) were evaluated: 1) duration of the phenological cycle (D), measured from the date of pruning to harvest (days), 2) production of bunches per plant (P) - weight of all bunches per plant (kg), 3) number of bunches per plant (BP); 4) mean bunches weight (BW) - total weight of all bunches divided by the total number of bunches per plant (g), 5) bunches length (BL), measured between the top and bottom of the rachis (cm) 6) width of the bunches (WB), measured between both extremity side of the rachis (cm), 7) total soluble solids (TSS), determined from a sample of ten berries per bunch in °Brix; 8) titratable acidity (TTA), determined from a sample of ten berries per bunch in percentage of tartaric acid /100 mL of juice; 9) the total soluble solids (TSS)/total titratable acidity (TTA). Five discrete characteristics were also evaluated: 1) consistency of the pulp: crisp, fleshy, muscilaginous, or juicy; 2) Taste: neutral, special, muscat or foxy; 3) Format of the bunches: cylindrical, cylindrical winged or cone; 4) Format of the berries: ovoid, globose or elliptical; 5) Color: Black, red, green or green-yellow.

Statistical analysis was performed using the software Genes 2007.0.0 (CRUZ, 2008). To carry out the multivariate analysis, the genetic distances between all pairs of accessions were obtained using the mean Euclidean distance as a measure of the dissimilarity for the quantitative variables and the index of dissimilarity for the discrete variables. Cluster analysis was performed by Tocher's optimization procedure. Diversity was also analyzed using the method of principal components. The relative importance of characters, used in the discrimination of clusters, was assessed at the discretion of the weight variables in eigenvectors. The eigenvectors and eigenvalues were obtained from the correlation matrix of standardized data of original values. The variables with higher weights were considered of minor importance, since the last eigenvector was associated with an eigenvalue greater than 0.70 (CRUZ et al., 2004).

RESULTS AND DISCUSSION

Morphoagronomic traits of continuous variables

The means of each cultivar and, average, maximum and minimum per group, according to the method of Tocher, for nine morpho-agronomic traits studied are shown in Table 2. Cluster analysis using the Tocher's optimization procedure allowed the formation of 12 groups (Table 3). Group 1 was composed by 41 accessions (62%), showing a small variability between wine grape cultivars in the Grape Germplasm Bank. Very different cultivars based on aspects such as genealogy, geographic origin and enological potential, were included in this group. Ninety percent of cultivars are *Vitis vinifera* L., however, interspecific hybrids, such as 'Mars' and 'Tampa' of the University of Arkanzas and 'Moscato Embrapa' and 'BRS Rubea' developed by Embrapa Uva e Vinho, belonged to the same group. Boseli et al. (2000) evaluated 11 cultivars of white wine grapes in the region of the Campaign in Italy, through clustering analysis and principal components based on 29 leaf measures. They observed the formation of four groups, in the group composed by the cultivars 'Asprinio', 'Falanghina di Benevento' and 'Greco di Tufo' there were significant differences in the wine characteristics, but the cultivars were similar in leaf morphology, suggesting a common phylogenetic origin.

The maximum distance (d = 3.07) was observed between 'Müller Thurgau' (group 5) and 'Barbera' (group 1), while the minimum (d = 0.24) was obtained between 'Regner' and 'Romania', both in group 1. The selection of parents for hibridization in a breeding program should consider not only the genetic divergence among accessions, but also their agronomic performance and characteristics.

The group 12, represented by 'BRS Lorena', had the longer phenological cycle, 138 days, while 'Siegerrebe' in group 9, was the earliest cultivar, harvested 87 days after pruning. Group 4 stood out for its higher average production per plant and group 5 for presenting larger bunches (weight, length and width), and soluble solids content (TSS). 'Pedro Ximenez' in group 11 and 'Campanario' in group 7 showed respectively the highest and lowest value for total acidity. On the other hand, the best TSS / TTA ratio was observed in group 4.

The principal component analysis showed that four components are necessary to explain 84.12% of the total variation and was used to plot the accessions in the three-dimensional space (Figure 1). The principal component 1 explained 36.67% of the total variance, associated with bunches size characteristics (weight, length and width). The component 2, representing 18.66% of the variance, was associated with the chemical characteristics of the grape (TSS/TTA, TTA and TSS). The component 3, explaining 15.99% of the variance was correlated with the yield (number of bunches and yield per plant). Finally, the main component 4, explaining 12.79% of the total variance was correlated with the bunches maturation, because the highest scores were obtained for the duration of the phenological cycle, TSS/TTA, TTA and TSS. Fatahi et al. (2004) analyzed 90 grape varieties using principal components found that seven components were needed to explain 81% of the total variance, with the first factor was related to the berry characteristics and the second factor was associated with bunches characteristics. Looking at Table 4, it is possible to identify the variables of greatest weight in the last eigenvectors. However, the highest score in the last eigenvector was higher than 0.70, associated with the characteristic bunches weight, indicating that no trait can be discarded. Borges et al. (2008) obtained eight groups of seeded grape cultivars and one group of seedless grape cultivars by principal componentes in the same germplasm collection. They observed an agreement between the most divergent accessions of seeded and seedless table grapes cultivars by two multivariate methods: principal components and the mean Euclidean distance.

Table 5 showed the existence of positive and significant correlation between different morpho-agronomic traits; however the Pearson's correlation coefficients were very low. The correlation between yield per plant and total acidity was high and positive (r = 0.88), indicating that the higher the yield, the greater the acidity of the berry. Fatahi et al. (2004) obtained a negative correlation between yield per plant and content of soluble solids.

The evaluation of a great number of characters, especially those related to the wine enological characteristics, such as anthocyanins, polyphenols, tannins among others, is necessary not only for a better differentiation of the groups, but also to provide a more complete set of information for the selection of parents based on their phenotypic characteristics.

Morpho-agronomic traits of discrete variables

Cluster analysis by the Tocher's optimization procedure based on five discrete variables resulted in the formation of 8 groups (Table 6). Forty-eight accessions (72.7%) were concentrated in group 1, which included the main wine grape cultivars of the Sub Middle São Francisco River basin, such as, 'Cabernet Sauvignon', 'Syrah', 'Chenin Blanc', 'Tannat', 'Ruby Cabernet', among others. Although the groups based on discrete variables are different from those based on quantitative variables, there was a coincidence of 69% of accessions in group 1. The group 1 was composed exclusively by cultivars of *Vitis vinifera*, the hybrids are all separated into distinct groups. The clustering based on morpho-agronomic discrete variables allowed the separation between accessions of the specie *Vitis vinifera* and hybrids, which was not observed in the evaluation of continuous variation traits. According to Martinello et al. (2002), this occurs mainly because the quality characteristics are controlled by few genes and thus are little affected by the environment.

The results of multivariate analysis showed little variation among accessions of wine grape in the Germplasm Bank of Embrapa Semiarid. This can be explained because that collection was composed mainly by classic and traditional cultivars in the international wine market. According to This et al. (2006), there was a significant reduction in genetic diversity of grapevines in the last 50 years as a consequence of the globalization of wine companies and markets, which limited the cultivars to a small number, leading to the disappearance of old local varieties or landraces.

TABLE 1 - Wine grape cultivars, origin and specie evaluated in this work.

Acessions	Number	Origin	Specie	Pedigree
Altesse	1	*V. vinifera*	France	
Ancellotta	2	*V. vinifera*	Italy	
Aramon	3	*V. vinifera*	France	
Baco Blanc	4	*V. vinifera*	France	Folle Blanche X Noah
Barbera	5	*V. vinifera*	Italy	
Bordô	6	Hybrid	USA	(Isabella x Labrusca) X O.P.
BRS Lorena	7	Hybrid	Brazil	Malvasia Bianca X Seival
BRS Rubea	8	Hybrid	Brazil	Niagara Rosada X Bordo
Burger	9	*V. vinifera*	Germain	Heunisch x (*Vitis sylvestris* x Traminer)
Cabernet Sauvignon	10	*V. vinifera*	France	Cabernet Franc X Sauvignon Blanc[1]
Campanário	11	*V. vinifera*	Portugal	Camarate Preto X Fernao Pires
Carignane	12	*V. vinifera*	France	
Castelão	13	*V. vinifera*	Portugal	
Chasselas Doré	14	*V. vinifera*	France	
Chenin Blanc	15	*V. vinifera*	France	
Cinsaut	16	*V. vinifera*	France	
Colombard	17	*V. vinifera*	France	Heunisch Weiss X Chenin Blanc
Feher Szagos	18	*V. vinifera*	Hungary	
Flora	19	*V. vinifera*	USA	Semillon X Traminer
Gamay	20	*V. vinifera*	France	Pinot x Heunisch Weiss
Gamay Beaujolais	21	*V. vinifera*	France	
Gewurztraminer	22	*V. vinifera*	Germain	
Grand Noir	23	*V. vinifera*	France	Aramon X Petit Bouschet
Grenache	24	*V. vinifera*	Spain	

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Acessions	Number	Origin	Specie	Pedigree
Lassif	25	?	?	
Malvasia Branca	26	*V. vinifera*	Portugal	
Malvasia Chartrense	27	*V. vinifera*	?	
Malvasia di Lipari	28	*V. vinifera*	Italy	
Mars	29	Hybrid	USA	Island belle X A1339
Moscato Embrapa	30	Hybrid	Brazil	Couderc 13 X July Muscat
Moscato di Canelli	31	*V. vinifera*	Italy	Muscat de Alexandria X ?
Mouverdre	32	*V. vinifera*	Spain	
Muller Thurgau	33	*V. vinifera*	Switzerland	
Olivette Noire	34	*V. vinifera*	France	
Palomino	35	*V. vinifera*	Spain	
Pedro Ximenez	36	*V. vinifera*	Spain	
Periquita	37	*V. vinifera*	Portugal	
Petit Syrah FR	38	*V. vinifera*	France	Dureza de Ardeche X Mondeuse Blanche
Petit Syrah RS	39	*V. vinifera*	France	Dureza de Ardeche X Mondeuse Blanche
Petit Verdot	40	*V. vinifera*	France	
Peverella	41	*V. vinifera*	Italy	
Red Vletliner	42	*V. vinifera*	?	
Regner	43	*V. vinifera*	German	Luglienca Bianca X Gamay Precoce
Riesling do Reno	44	*V. vinifera*	German	
Riesling Itálico	45	*V. vinifera*	France	
Riesling Renano	46	*V. vinifera*	German	
Royalty	47	*V. vinifera*	USA	Alicante Ganzen X Trousseau
România	48	?	?	
Ruby Cabernet	49	*V. vinifera*	USA	Cabernet Sauvignon X Carignan
Sangiovese	50	*V. vinifera*	Italy	
Sauvignon Blanc	51	*V. vinifera*	France	Traminer X ?
Seara Nova	52	*V. vinifera*	Portugal	Diagalves X Fernao Pires
Semillon	53	*V. vinifera*	France	
Siegerrebe	54	*V. vinifera*	German	Madeleine Angevine x Traminer Rot
Souzão	55	*V. vinifera*	Portugal	
Sylvaner	56	*V. vinifera*	Austria	Oesterreichisch Weiss x Traminer
Tampa	57	Hybrid	USA	*Vitis smalliana* O.P. X Niagara
Tannat	58	*V. vinifera*	France	
Tempranillo	59	*V. vinifera*	Spain	
Tibouren	60	*V. vinifera*	France	
Tinta Roriz	61	*V. vinifera*	Spain	
Tocai Friulano	62	*V. vinifera*	Italy	
Riparia do Traviu	63	*V. riparia*	Brazil	
Trebbiano Toscano	64	*V. vinifera*	Italy	
Ugni Blanc	65	*V. vinifera*	Italy	
Verdea	66	*V. vinifera*	France/Italy	

TABLE 2 - Means of 66 wine grape cultivars, according to the Tocher cluster analysis, considering nine characters of continuous variation.

Acessions	Group	D	P	BP	BW	BL	WB	TSS	TTA	TSS/TTA
Altesse	1	109	3.44	45	94	10.01	5.37	19.50	0.70	29.50
Ancelota	1	119	1.63	37	87	10.13	5.20	20.18	0.55	37.90
Baco Blanc	1	118	1.63	15	109	10.63	5.51	18.21	0.90	26.30
Barbera	1	119	1.86	29	89	10.80	5.25	20.05	0.69	29.44
BRS Rubea	1	103	2.98	37	168	15.24	7.15	21.13	0.72	36.27
Cabernet Sauvignon	1	133	1.45	26	76	9.36	5.51	13.70	1.35	21.14
Castelão	1	119	6.23	37	218	13.25	7.55	17.65	0.54	32.60
Chansselas Doré	1	108	5.99	38	164	12.35	5.47	17.62	0.61	28.83
Cinsaut	1	119	2.88	32	119	12.07	5.31	19.91	0.96	23.40
Feher Szagos	1	107	2.73	14	143	11.16	5.68	20.56	0.76	28.75
Gamay	1	117	3.49	24	204	12.27	9.40	18.67	0.74	28.36
Gamay Beaujolais	1	116	3.45	36	129	10.42	7.08	19.58	0.71	29.48
Gewurztraminer	1	120	3.30	25	251	14.44	7.91	19.65	0.71	35.88
Grenache	1	132	3.93	43	113	10.90	6.19	17.86	0.73	30.48
Lassif	1	118	3.37	22	209	14.35	9.58	19.99	0.59	35.86
Malvasia di Lipari	1	101	2.69	29	138	11.59	6.33	17.64	0.71	27.66
Mars	1	115	2.91	37	107	10.60	5.78	17.11	0.51	43.59
Moscato Embrapa	1	111	2.34	26	140	13.69	6.24	21.53	0.56	43.52
Moscato di Canelli	1	126	3.49	21	187	13.83	6.69	19.48	0.66	31.63
Periquita	1	119	1.17	9	89	9.37	5.80	20.30	0.50	29.60
Petit Sirah (FR)	1	115	3.39	35	109	14.91	5.69	20.44	0.91	27.70
Petit Sirah (RS)	1	121	2.61	27	90	10.39	5.53	19.54	0.54	37.97
Petit Verdot	1	119	0.74	10	126	11.75	5.75	18.50	0.74	26.18
Peverella	1	123	4.70	25	201	17.00	6.20	20.10	0.56	36.55
Red Vletliner	1	116	3.60	19	169	14.90	5.95	20.49	0.61	34.94
Regner	1	119	3.45	30	110	11.35	5.67	18.64	0.59	31.72
Riesling Itálico	1	116	3.00	44	76	9.84	4.56	18.78	0.76	26.51
Riesling Renano	1	123	2.88	46	75	9.71	4.76	19.12	0.68	33.20
România	1	121	2.86	30	107	12.83	5.80	18.42	0.58	32.24
Ruby Cabernet	1	119	1.19	20	118	11.24	5.55	18.01	0.80	24.44
Sangiovese	1	129	2.40	26	161	13.36	5.43	19.12	0.66	33.51
Sauvignon Blanc	1	120	2.21	23	124	11.04	5.32	18.46	0.69	29.62
Seara Nova	1	119	5.19	33	191	14.34	7.05	19.01	0.75	29.81
Semillon	1	108	3.57	34	114	11.91	5.62	19.03	0.68	29.65
Souzão	1	125	3.52	32	142	13.36	5.86	21.00	0.67	36.69
Sylvaner	1	118	4.31	54	111	9.27	5.03	19.36	0.54	36.95
Tampa	1	120	1.60	25	99	11.36	5.65	17.15	0.82	27.63
Tannat	1	121	4.16	27	182	12.06	6.25	19.88	0.69	30.84
Tibouren	1	130	3.82	36	161	14.28	7.43	17.39	0.47	38.33
Tocay Fruilano	1	124	2.35	31	130	11.70	6.55	17.70	0.57	42.42
Trebbiano Toscano	1	132	1.17	11	110	11.05	5.42	18.36	0.61	31.72
Means	**1**	**119**	**3.02**	**29**	**135**	**12.05**	**6.10**	**18.99**	**0.69**	**31.92**

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Acessions	Group	D	P	BP	BW	BL	WB	TSS	TTA	TSS/TTA
Aramon	2	136	3.95	24	225	16.19	8.34	16.93	0.58	30.38
Burguer	2	130	5.45	26	269	17.23	7.32	16.74	0.71	25.26
Carignane	2	133	5.71	41	212	14.02	6.99	17.38	0.68	25.80
Chenin Blanc	2	132	6.37	35	265	14.44	6.96	18.05	0.85	26.24
Colombard	2	119	5.39	51	194	14.70	8.88	17.38	0.59	29.92
Grand Noir	2	129	5.17	33	228	15.06	7.82	19.33	0.55	41.73
Malvasia Bianca	2	136	4.12	14	365	16.63	8.45	17.43	0.51	34.36
Malvasia Chartrense	2	126	2.84	16	220	16.83	8.79	18.38	0.47	39.96
Mouverdre	2	126	5.24	21	300	15.74	8.89	16.53	0.47	37.73
Ugni Blanc	2	131	6.55	24	240	16.76	7.32	18.91	0.53	36.67
Verdea	2	133	3.55	22	206	16.57	6.61	20.03	0.75	42.26
Means	**2**	**130**	**4.94**	**28**	**247**	**15.83**	**7.85**	**17.91**	**0.61**	**33.67**
Bordô	3	110	0.72	4	39	7.23	3.67	19.00	0.82	24.05
Tempranillo	3	119	1.20	16	83	9.08	5.15	21.00	0.92	24.04
Means	**3**	**115**	**0.96**	**10**	**61**	**8.15**	**4.41**	**20.00**	**0.87**	**24.04**
Flora	4	122	6.11	40	180	12.88	5.77	21.09	0.53	40.72
Tinta Roriz	4	119	4.74	36	126	13.97	8.37	21.73	0.44	51.11
Means	**4**	**120**	**5.43**	**38**	**153**	**13.43**	**7.07**	**21.41**	**0.49**	**45.92**
Muller Thurgau	5	133	2.79	8	421	19.06	10.92	18.01	0.49	37.22
Palomino	5	118	4.85	22	340	19.01	11.30	17.04	0.73	27.87
Means	**5**	**125**	**3.82**	**15**	**380**	**19.03**	**11.11**	**17.53**	**0.61**	**32.54**
Olivette Noire	6	106	4.22	16	190	16.99	8.44	16.89	0.66	30.57
Riparia do Traviu	6	110	5.27	47	130	14.32	10.57	18.69	0.53	30.09
Means	**6**	**108**	**4.74**	**32**	**160**	**15.66**	**9.51**	**17.79**	**0.60**	**30.33**
Campanário	**7**	131	4.98	46	174	12.04	6.91	15.73	0.44	36.30
Riesling do Reno	**8**	127	0.47	8	126	9.30	6.85	16.50	0.67	24.82
Siegerrebe	**9**	87	0.53	6	174	13.85	8.90	21.38	0.48	44.25
Roialty	**10**	120	0.92	9	76	9.20	4.67	20.13	0.51	42.40
Pedro Ximenez	**11**	114	0.54	3	158	11.03	9.00	18.13	1.11	16.3
BRS Lorena	**12**	138	0.99	9	97	9.03	5.81	17.82	0.89	43.42

D: Duration of cycle (days between pruning and harvesting); P: yield per plant (Kg); BP: number of bunches per plant; BW: Bunch weight (g); BL: Bunch Length (cm); WB: Bunch Width (cm), TSS: total soluble solids (°Brix); TTA: total titratable acidity (% TA); TSS / TTA: Relationship °Brix/titratable acidity.

TABLE 3 - Grouping according to Tocher's optimization procedure, considering nine continuous variation traits evaluated in 66 wine grape accessions.

Groups	Acessions
1	43 48 51 5 39 50 58 31 21 53 55 42 2 46 1 45 24 52 62 57 49 18 40 4 28 64 10 16 38 22 20 37 14 29 56 41 60 25 8 30 13
2	23 65 66 27 3 32 26 9 12 15 17
3	6 59
4	19 61
5	33 35
6	34 63
7	11
8	44
9	54
10	47
11	36
12	7

TABLE 4 - Estimates of eigenvalues (λ) and eigenvectors associated with the principal components in 66 wine grape accessions and nine morphological and agronomic traits of continuous variation. Bold values highlight the characteristic of greater weight in their eigenvector.

Traits	PC 1	PC 2	PC 3	PC 4	PC 5	PC 6	PC 7	PC 8	PC 9
D	0.1824	0.2369	0.2815	**0.6143**	-0.5659	0.2	0.272	0.0978	0.1011
P	0.3981	-0.1157	0.4204	-0.2958	-0.148	-0.3069	0.0044	-0.5069	0.4368
BP	0.0921	-0.3604	**0.6411**	-0.2829	0.014	0.3816	0.0045	0.2999	-0.3672
BW	**0.4842**	0.2497	-0.1483	-0.06	-0.1081	-0.1837	0.0312	-0.2665	**-0.7484**
BL	0.4839	0.0986	-0.1712	-0.1884	-0.1776	-0.1874	-0.3597	**0.6709**	0.2127
WB	0.425	0.1817	-0.2561	-0.1762	0.3024	**0.6606**	0.3077	-0.095	0.2413
TSS	-0.1064	-0.4378	-0.407	-0.3423	**-0.5831**	0.0231	0.4157	0.0221	-0.0189
TTA	-0.301	0.4484	0.028	-0.361	-0.42	0.3669	-0.473	-0.2061	-0.0026
TSS/TTA	0.2206	**-0.5503**	-0.2229	0.3709	-0.0811	0.2824	**-0.5517**	-0.2653	-0.0126
λ	**3.30**	**1.68**	**1.44**	**1.15**	**0.68**	**0.30**	**0.21**	**0.14**	**0.10**
λ (%) accumulated	**36.67**	**55.34**	**71.34**	**84.12**	**91.69**	**94.98**	**97.27**	**98.86**	**10**

TABLE 5 - Pearson's correlation coefficients obtained among nine traits, of continuous variation, in 66 wine grape accessions from the Grape Germplasm Bank of EMBRAPA Semi Arid.

Traits	D	P	BP	BW	BL	WB	TSS	TTA
P	0.19^{ns}							
BP	0.03^{ns}	0.56**						
BW	0.31*	0.53**	-0.21^{ns}					
BL	0.18^{ns}	0.57**	-0.12^{ns}	0.84**				
WB	0.06^{ns}	0.41**	-0.12^{ns}	0.76**	0.74**			
TSS	-0.2^{ns}	0.07^{ns}	-0.05^{ns}	0.20^{ns}	0.26*	0.27*		
TTA	0.005^{ns}	-0.34**	-0.20^{ns}	-0.29*	-0.33**	-0.36**	-0.07^{ns}	
TSS/TTA	0.07^{ns}	0.15^{ns}	0.18^{ns}	0.13^{ns}	0.24*	0.20^{ns}	0.07^{ns}	-0.68**

(**) e (*) significant at 1 and 5% of probability, respectively, by the t test.

TABLE 6 - Grouping according to Tocher's optimization procedure, based on five discrete variables evaluated in 66 wine grape accessions.

Groups	Acessions
1	1 14 17 22 41 53 62 2 5 10 11 12 38 39 40 49 50 58 3 42 43 44 45 52 16 20 21 23 24 32 47 4 18 25 46 51 56 64 65 66 9 15 60 28 35 36 19 61
2	6 29 57 63 55
3	13 34 37 59
4	26 30 31 33
5	27 54
6	8
7	7
8	48

CONCLUSIONS

1- The multivariate statistics to study genetic diversity applied to continuous variable traits (Tocher's optimization procedure and principal components) were consistent with each other.

2- There was no correlation between the formation of the groups using continuous and discrete variables.

3-There is little genetic variability between wine grape accessions in the Grape Germplasm Bank of Embrapa Semi-Arid.

4- Cluster analysis based on morpho-agronomic traits resulted in the separation of accessions according to common phenotypic traits.

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