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Tunisian South Cultivated Grapevine (*Vitis vinifera* L.) -Foliar Composition on Major Mineral Elements-

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Abstract: The diversity of the local grapevine varietal set of Tunisia was remarkably noted in areas of Sfax, Kerkhennah, Gabes, Tozeur, Nafta, Degache, Zarzis and Djerba. Some varieties showed requested characteristics at the level of the production quality, its lateness and its fitness to take on tree, and its adaptation to various Tunisian pedoclimatic conditions. In an attempt to explore the genetic diversity of 25 autochthones cultivars of grapevine (*Vitis vinifera* L.) in South East of Tunisia, the determination of leaves composition on major mineral elements (Na, K, Ca, Mg, Cu, Zn, Fe and Mn) have permitted to appreciate the genetic variability inter-cultivars and its structuring in this collection. Data (PCA plot, cluster analysis) provide that some of these parameters were designed suitable to discriminate significantly few cultivars (ARCz, KORg, BAKz, MGB, BAK, TON, SAKj…). In fact, the recorded differences could be due to sever environmental conditions such as: nature of the soil, culture and climatic conditions, irrigation, salinity, position of leaves on the branches, rootstock etc.

Key words: Cluster analysis, Genetic diversity, Leaves mineral nutrients, PCA plot, *Vitis vinifera* L.

1. Introduction

Several native grapevine (*Vitis vinifera* L.) genotypes, highly appreciated for their organoleptic characteristics and commercial potential, are widely cultivated in Tunisia, from the Kroumirie-ogods mountains (North-West, humid climate) to the desert region of Rjim-maâtoug (South-West, arid climate) (Zoghlami et al., 2001). Developing viticulture requires the conservation of autochthonous varieties that have evolved several mechanisms enabling them to cope with the local bioclimatic and edaphic conditions (Ben Abdallah et al., 1998).

The survey of the genetic distinctness of Tunisian grapevine cultivars can provide some information to enhance the evaluation, the conservation and the improvement of this phytogenetic patrimony. The present study was interested to the mineral composition of leaves to appreciate the genetic diversity and its structuring among the 25 studied grapevine genotypes.

2. Materials and Methods

2.1. Plant tissue samples and mineral analysis

Adult leaves of 25 local grapevine cultivars (**Table 1**, **Fig. 1**) were sampled. A total of 30 leaves per cultivar were taken from lower, middle and upper regions of the plant, bulked together and transported to the laboratory. Leaves were taken out from 1, 2 or 3 individuals depending on number of individuals per cultivars available. The concentrations of the main mineral elements (Na, K, Ca, Mg, Cu, Zn, Fe and Mn) were determined using an atomic absorption spectrophotometer (SHIMADZU AA 6800). Before the analysis, leaves were oven-dried for 48 h at 70 ˚C and ground to pass through a 1 mm diameter sieve. Four grammes were calcinated for 6 hours at 500 ˚C and digested by adding 5 ml of concentrated HCl and 3 ml H_2O and boiled. Each sample was filtered and brought up to the final volume of 100 ml with deionised water.

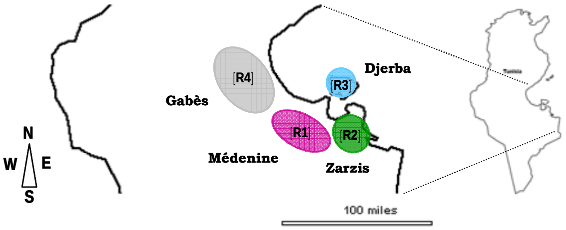

Fig. 1. Sampling localities of the studied cultivars.

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2.2. Statistical analysis

In order to show the relationships among the 25 studied grapevine genotypes, the recorded data (mineral levels) were analyzed by numerical taxonomic technique using the procedure of principal component analysis (Sneath and Sokal, 1973). Eigenvectors and eigenvalues of the first four principal component axes were calculated on the basis of a similarity correlation matrix. Hierarchical clustering was then carried out using Pearson's correlation coefficients between groups linkage.

Table 1. List of studied grapevine cultivars, their geographical region of production and designation.

Cultivar	Origin	Designation
Beldi	IRA (El Fjé-Médenine)	BLD
Razzagui	IRA (El Fjé-Médenine)	RAZ
Siper abiadh	IRA (El Fjé-Médenine)	SAB
Miski	IRA (El Fjé-Médenine)	MIS
Bazzoul kalba	IRA (El Fjé-Médenine)	BAK
Tounsi	IRA (El Fjé-Médenine)	TON
Mguargueb	IRA (El Fjé-Médenine)	MGB
Arabi	IRA (El Fjé-Médenine)	ARB
Dalia	IRA (El Fjé-Médenine)	DAL
Akhal	IRA (El Fjé-Médenine)	AKH
Akhal tawil	IRA (El Fjé-Médenine)	AKT
Bazzoul kalba	Zarzis	BAKz
Razzagui	Zarzis	RAZz
Miski	Zarzis	MISz
Aricha	Zarzis	ARCZ
Nab jmel	Zarzis	NAJz
Mguargueb	Djerba	MGBj
Sakasli	Djerba	SAKj
Tounsi	Djerba	TONj
Bazzoul kalba	Chénini Gabès	BAKg
Miski	Chénini Gabès	MISg
Médina	Chénini Gabès	MEDg
Korkobbi	Chénini Gabès	KORg
Mlouhi mkarkeb	Chénini Gabès	MMKg
Saoudi	Chénini Gabès	SADg

Table 2. Mineral composition (mg/100 g dry weight) of 25 accessions of Tunisian grapevine.

Cultivars	Na	K	Ca	Mg	Cu	Zn	Fe	Mn
BLD	0.038	1.426	1.618	0.146	0.00030	0.0015	0.027	0.004
RAZ	0.083	0.746	2.363	0.303	0.00033	0.0025	0.029	0.011
SAB	0.089	1.091	0.914	0.147	0.00057	0.0015	0.026	0.003
MIS	0.084	1.124	1.087	0.190	0.00039	0.0026	0.019	0.011
BAK	0.043	1.178	0.777	0.135	0.00027	0.0020	0.012	0.002
TON	0.093	1.199	0.931	0.119	0.00015	0.0011	0.049	0.002
MGB	0.058	1.596	1.297	0.130	0.00036	0.0014	0.022	0.003
ARB	0.063	0.867	3.761	0.305	0.00045	0.0035	0.101	0.010
DAL	0.060	1.292	2.383	0.233	0.00044	0.0020	0.087	0.005
AKH	0.052	0.723	1.517	0.165	0.00038	0.0027	0.029	0.005
AKT	0.042	1.512	1.598	0.215	0.00029	0.0019	0.017	0.003
BAKz	0.154	0.579	3.841	0.309	0.00061	0.0020	0.107	0.006
RAZz	0.065	0.605	3.626	0.350	0.00139	0.0022	0.055	0.006
MISz	0.065	0.660	3.496	0.296	0.00134	0.0021	0.107	0.007
ARCZ	0.057	2.582	1.480	0.277	0.00188	0.0018	0.033	0.004
NAJz	0.077	0.448	2.371	0.392	0.00088	0.0016	0.066	0.013
MGBj	0.036	0.437	4.336	0.559	0.00039	0.0013	0.031	0.009
SAKj	0.032	0.270	2.600	0.230	0.00067	0.0006	0.033	0.005
TONj	0.048	0.369	3.707	0.546	0.00044	0.0016	0.051	0.005
BAKg	0.033	0.973	3.134	0.264	0.00055	0.0021	0.048	0.004
MISg	0.051	0.532	2.517	0.335	0.00037	0.0017	0.057	0.013
MEDg	0.045	0.953	4.679	0.475	0.00054	0.0024	0.068	0.006
KORg	0.049	1.428	3.742	0.512	0.00112	0.0039	0.053	0.005
MMKg	0.014	0.645	2.578	0.275	0.00041	0.0014	0.020	0.003
SADg	0.040	0.953	2.750	0.341	0.00082	0.0022	0.054	0.003

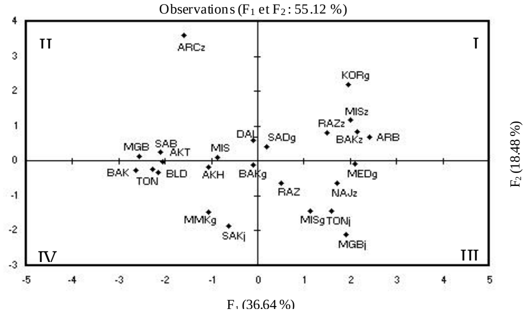

Fig. 2. Plot of the first and second component scores for 25 accessions of Tunisian grapevine based on mineral content.

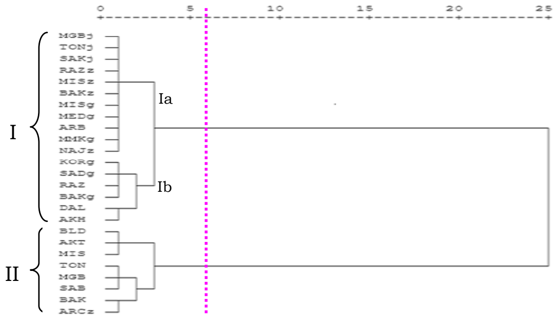

Fig. 3. Dendrogram of 25 accessions of Tunisian grapevine following Pearson's correlation coefficients.

3. Results and Discussion

3.1. Mineral composition

Among the 8 parameters studied (**Table 2**), the calcium represents the major element ranging from 0.77 to 4.68 mg/100 g, registered in BAK and MEDg cultivars, respectively. It is followed by the potassium content. ARCz had the highest content (2.58 mg/100g) and the least proportion (0.27 mg/100g) had been registered in SAKj. The magnesium content has middling levels, with an average of 0.3 mg/100g. All the remaining elements had levels less than 0.16 mg/100g, copper was detected on traces.

3.2. Principal component analysis

In order to assess the patterns of variations, Principal Components Analysis (PCA) was done considering all the 8 variables simultaneously (**Fig. 2**). The first 4 principal components (PCs) accounted for 82.95% of the variability amongst the 25 accessions. The first PC (PC1) accounted for 36.64% of the total qualitative variation and had calcium, magnesium, iron and manganese with high positive and potassium with high negative coefficients. The second component (PC2) contributed for an additional 18.48% of the total variation, depicted primarily the patterns of variation in potassium, copper and zinc all having high positive coefficients. PC3 accounted for 16.60% of the variability among the 25 accessions and described the patterns of variation in sodium and manganese contents, which increased at the expense of calcium and magnesium since these 2 had negative coefficients. PC4 constituted 11.23% of the variation and had zinc and manganese, both with high positive coefficients, copper and iron with negative signs.

The patterns of divergence between the 25 accessions for the first 2 principal components are given in Figure 1. For ease of understanding the space is divided into 4 quadrants (I–IV) each originating from the point of intersection of the lines passing through the respective averages of the component axes. It can be discerned from the figure that the mineral diversity of the accessions was large. Four accessions (KORg, ARB, MISz and RAZz) occupied the first quadrant that designates positive values of both the components. The IInd quadrant had three accessions. Opposing on SAB and MGB, ARCz showed the highest positive coefficient of the IInd component. Three accessions occupied the IVth quadrant. TON and BAK showed negative coefficients of the Ist component. SAKj diverge considerably from the other and had negative coefficients of the IInd component. However, five accessions occupied the IIIrd quadrant, which designates positive coefficient of Ist component and negative value of the second (Fig. 2).

3.3. Cluster analysis

The accessions were broadly grouped into 2 clusters (**Fig. 3**) following Pearson's correlation coefficients, whereby the individuals in any one cluster are more closely related than the individuals in different clusters. The Ist cluster had 17 accessions and can be subdivided into two sub groups Ia and Ib. It was interesting to note that cluster I contains accessions from Djerba, Zarzis and Gabes in most. Cluster Ia was the largest, included 11 accessions characterised by high content in calcium and magnesium. Cluster Ib contained 6 accessions that had most amount of zinc. 8 accessions were included in cluster II that was subdivided into IIa and IIb. These accessions are in most from IRA Medenine. BLD, AKT and MIS, in cluster IIa, were characterised by moderate amount of all mineral contents. Cluster IIb (TON, MGB, SAB, BAK and ARCz) was characterized by slight amount of calcium and magnesium and quiet high levels of potassium, ARCz was the richest cultivar in this latter (Fig. 3).

Dendrogram clustering showed the same accessions grouping displayed by the PCA plot. In fact, the two classification methods prove that there is a strong relationship between diversity and geographical origin.

Recorded variability could be explained both with regard to genetically differences and environmental conditions such as: nature of the soil, culture and climatic conditions, irrigation, salinity, position of leaves on the branches, rootstock etc. (Bouillet, 1996). Earlier, several works was interested in the study of the origin of these differences. Among the most reported factors, we noted the effect of the physicochemical composition of the ground on the plant content of mineral elements (Wallace, 1943).

Indeed plant nutrition depends on soil mineral nutrients, but also on its pH which has a strong influence on the assimilation of these biogenic salts (Vilain, 1993) and on its fertilization (Christensen, 2005). Another component of the grounds of extreme importance is water. In fact, any deficiency or excess of water can play a determining role on roots function, culture production and tissue mineral contents (Keller, 2005). The role of the mode of irrigation has been evidenced on the growth and the mineral nutrition of the grapevine (Paranychianakis *et al*., 2006). Moreover, the effect of the rootstock on the content of mineral elements has been reported on many researches (Spring *et al*., 1999).

4. Conclusions

The Tunisian grapevine accessions studied displayed considerable level of variability for all the minerals. In fact, some of these parameters were designed suitable to discriminate significantly few cultivars (ARCz, KORg, BAKz, MGB, BAK, TON, SAKj…). PCA plot and cluster analysis have proved to be an effective method in grouping accessions. In fact, it is important to ascertain the extent of genetic diversity available in the material for its effective utilization in breeding programs.

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