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Diversity of the olive tree (*Olea europaea* L.) genetic resources in the region of Ouazzane (North of Morocco): characterization by using the morphological descriptors

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ABSTRACT

In this study, 15 morphological descriptors were used to characterize and to determine the genetic diversity of the olive tree in the region of Ouazzane, represented by 21 local and foreign cultivars and suspected clones of Picholine Marocaine and types of oleasters. Relating to the organs, the discriminating potential of the fruit characters was higher than that of the endocarp and leaf characters. The similarity index of Rogers Tanimoto between varieties and the studied local types ranged from a minimum of 56, 66% to a maximum of 100%. Picual individuals of Ouazzane and Mjaara areas are similar for all 15 discriminating characters. The same observation was noted for the Picholine Marocaine individuals' type M6, S1 and S2. The individuals Ascolana tenera of Sidi Bousber and Ouazzane areas are also identical. Traditional varieties (Bouchouk Laghlide, Bouchouk Rkike, Bakhboukh Beldi, Bouchouika and Dahbia) were identified by a distinct phenotype, with a tendency to morphological similarity between the two varieties Bouchouika and Bouchouk Rkike. Similarly, six types of local oleaster have been identified by many different phenotypic characters and the majority showed an interesting oil contents. The individuals Picual OU and Picual MJ, Picholine du Languedoc, Ascolana tenera OU, Ascolana tenera SB, the varieties Cucco, Ascolana dura, Manzanille and Gordal, have proved authentic by comparing their 15 discriminating characters with those described in the literature. Among the types G9, G10 of the Picholine Marocaine in the region of Mjaara, and M1 in the Masmouda region, low morphological variability was observed and are different by the character distribution of the endocarp grooves, grouped around the suture in the first group (M1, G9, G10) and uniform in the second (M6, S1, S2). Thus, we identified two types of Picholine Marocaine (Zitoun El Hor) specific to the region of Mjaara: G9 and G10, a type of Picholine Marocaine (Zitoun Beldi) suitable to the region of Masmouda: M1. Also, six local oleaster types have been identified, these types was BM4, BMM and BMR in the region of Mjaara and those represented by BM2, BM3, and BMK in the Masmouda region.

The cluster analysis revealed 6 groups of varieties and local types at agglomeration, with a 75% of similarity. Group I, constituted by local varieties (Bouchouk Laghlide,Bouchouk Rkike,Bouchouika).GroupII includes all types of the Picholine Marocaine variety (M1,M6,G9,G10,S1,S2),the oleaster types (BMK, BMM), the local variety Bakhboukh Beldi, and the foreign variety Gordal. The Group III includes the foreign variety Picual in the regions of Mjaara and Ouazzane. Group IV, formed by Dahbia variety and three foreign varieties (Picholine du Languedoc, Ascolana tenera, Cucco). Group V, contains essentially the oleaster types (BM2 and BM4). The last group VI reassemble together the oleaster types (BM3, BMR) and foreign varieties (Ascolana dura, Manzanille). Most Mediterranean varieties from Spain, Italy, and France, are grouped in the groups IV and VI and the great majority of varieties and the Moroccan local types have a local geographic distribution, are grouped in the groups I and II. This similarity proves possible akin relationships, despite the genetic diversity of the studied material. This is explained by the fact that individuals of each different

locality are close geographically and genetically and they may have a common origin. These results guarantee to renovate an anxious olive cultivation to preserve and to enhance the existing genetic diversity and the valorization of the typicality of its obtained products.
Keywords: *Olive tree, indigene and foreign varieties, local types, clones, morphological characterization, identification, genetic diversity, genetic material or germoplasm, valorization.*

INTRODUCTION

The olive tree (Olea genus, *O.europaea*, *O.sylvestria*.) is a multi-perennial woody species belonging to the family of the Oleaceae which include too ornamental plants (fraxinus, ligustrum, syringa, jasminum, forsythia, phillyrea, alavert, arouet...), very characteristic of the Moroccan agricultural landscape[20]. Its culture has influenced the history and the culture of our country and marked the Mediterranean civilizations that have succeeded through the centuries[1,33,34].

The numerous of human migrations and commercial exchanges between East, Africa and Europe, (culture, goods, food, and evergreen plants) favoured the introduction of plant material by humans and the legacy of their genetic heritage and a very rich and diverse olive biodiversity.

The olive tree (wild and cultivated) is the only species enable to develop in the marginal lands and to satisfy the vital needs of rural populations[33,34]. The oleaster, in wild type or related spontaneous forms, is abundant in mountainous regions and constitutes the stands of the Mediterranean forests[37].

However, confusion occurred in the appellations of the ancient olive varieties, indigenous, traditional or local and foreign, due to situations of synonyms and frequent homonyms[25,26,27,28,29,30]. In Morocco, this problem takes on a largest ampleness, where the national olive groves consists of 98% of one variety called commonly Picholine Marocaine population (Zitoun Beldi, Zitoun, Zitoun El Hor, Zit) [21,22,23,7,9] which name masked several denominations of local varieties (Bouchouika, Meslala, Noukal, Gortbie, Berri Meslal, Zitoun Khoubzi, Zitoun El Hor) [19,35,21,7].

In addition, the high extent phenotypic heterogeneity of the Picholine Marocaine population variety is recorded in the Marrakech region, which is a standard genotype, may contains local clones[9].

The olive genetic resources are only partially identified and the valorization of the richness of olive varietal heritage (biodiversity) does not exist. Several studies suggest the utility of morphological descriptors (fruit, endocarp, leaf) for the characterization and the identification of the olive varieties[32,16,3].

More recently, a uniform procedure for the primary characterization of olive varieties was adopted in all olive growing countries of the Mediterranean basin[14,15], which is based on 15 discriminating morphological characters, have shown a very high levels of heritability and low variation due to the environmental conditions[11,33].

The objective of this work is to inventory, characterize and identify the richness and genetic diversity of the olive native heritage, Moroccan traditional varieties and possible local types cultivated under the name of Picholine Marocaine and the oleasters or wild forms and its related forms, as well as the different foreign varieties preserved in collections.

MATERIALS AND METHODS

Plant material

The studied plant material is composed of six local types cultivated under the name of Picholine Marocaine (Zitoun El Hor, Zitoun Beldi, Zitoun), 6 preselected types of local oleasters (Berri Meslal or Berri), 4 local varieties, only one cultivated traditional Moroccan variety (Dahbia) and 7 foreign introduced varieties and conducted in experimental and commercial orchards collection (Table I).

Morphological characterization

Morphological characterization of local varieties and local olive Moroccan types, as well as the foreign varieties comprised to apply the methodology of the primary characterization of olive varieties[14], which is a morphological description of fruit samples, endocarps, and leaves, taken from the adult tree. The combination of 15 morphological characters retained for the studied organs (fruits, endocarp, leaves), (Table II), they allowed to define reference types or own multi-character phenotype for each studied variety and local types.

Statistical analysis

The obtained phenotypes underwent Factorial Multiple Correspondence Analysis (AFCM) in an objective to discriminate between varieties.

The cluster analysis (CHA) was performed on a matrix categories of the studied morphological descriptors. This classification was carried out in the order to demonstrate, according to the degree of the morphological similarity, the possible groupings of the studied varieties and also to visualize the phenotypic relationships between them. The used aggregation criterion is the average distance that takes into account all phenotypes to recalculate the euclidean distances at each grouping. The used software was the Genstat.

Table I: Principal characteristics of the studied varieties

Region	Variety denominations and appellations synonyms	Geographical origin	Destination or end of production
Masmouda	Bouchouk Laghlide, Bouchouka	Morocco	Table
	Zitoun Meslala, Zitoun Tamri	Morocco	Oil
	Bouchouk Rkike, Bouchouk Beldi	Morocco	Oil
	Berri Meslal 3, Berri	Morocco	Oil
	Berri Meslal 2, Berri Berri Meslal K, Berri	Morocco	Oil
	Type PMM1,Zitoun, Zitoun El Hor Type PMM6,Zitoun,Zitoun El Hor	Morocco Morroco	Oil + Table Oil + Table
Ouazzane (Oued Dahab Collection)	Dahbia, Zitoun Bouchouika, Tounsia	Morocco	Oil + Table
	Picual OU, Zitoun Roumi ou Boudbiba	Spain	Oil
	Picholine du Languedoc, Zitoun Bouchouika	France	Oil + Table
	Gordal, Zitoun Fakhfoukhi, Zitoun Gortbie, Fakhfoukha	Spain	Table
	Manzanille de Séville	Spain	Table
	Ascolana Tenera OU, Zitoun Roumi,	Italy	Table
	Zitounn Barkouki, Zitoun Chahdia	Italy	Table
	Ascolana Dura, Zitoun Roumi Cucco, Zitoun Roumi	Italy	Table Table
MJAARA	Bouchouika, Bouchouk	Morocco	Oil
	Type PM G9, Zitoun El Hor	Morocco	Oil + Table
	Type PM G10, Zitoun El Hor	Morocco	Oil + Table
	Picual MJ, Zitoun Roumi	Spain	Oil
	Berri Meslal 4, Berri	Morocco	Oil
	Berri Meslal M, Berri	Morocco	Oil
	Berri Meslal R, Berri	Morocco	Oil
SIDI BOUSBER	Bakhboukh Beldi, Fakhfoukha Zitoun Fakhfoukhi, Zitoun Khoubzi	Morocco	Table
	Type PM S1**,** Zitoun Beldi, Zitoun Type PM S2**,** Zitoun Beldi, Zitoun	Morocco Morocco	Oil + Table Oil + Table
	Ascolana Tenera SB, Zitoun Roumi,	Italy	Table

Table II: List of the used morphological characters

Studied characters	Abreviations
Leaf : - Shape* (Ratio Length / Width) 1- Elliptic 2-Elliptic 3- Lanceolate	FFE
Fruit :- Shape* (Ratio Length / width) 1- Spherical 2- Ovoid 3- Elongated	FFR
Position of maximum transverse diameter (Position B)* 1- Towards base 2-Central 3- Towards apex	DMF
Nipple* 1-Obvious 2- Tenuous 3-Absent	Mam
Initial localization of changing color of the pulp* 1- From the base 2- Uniformly across the whole epidermis 3-From the apex	LIV

III- Characters of the endocarp: **Shape*** (Ratio Length / width) 1- Spherical 2-Ovoid 3-Elleptic 4-Elongated	FOE
Symmetry (**in a position A**)* 1-Symmetic 2- Slightly asymmetric 3- Asymmetric	SAE
Symmetry (in a position B)* 1-Symmetric 2- Slightly asymmetric	SBE
Position of maximum transverse diameter (Position B)*1-Towards base 2-Central 3- Towards the apex	DIE
Apex* 1- Pointed 2- Rounded	STE
Base* 1- Truncate 2 – Pointed 3- Rounded	BAE
Surface* 1-Smooth 2- Rugose 3- Scabrous	SUE
Number of grooves * 1- Low 2-Medium 3-High	NSE
Distribution of grooves * 1- Regular 2- Grouped around the suture	DSE
Terminates of the apex*1-With mucro 2-Whithout mucro	Muc

(*):15 characters recognized by the high discriminatory potential for the characterization of olive varieties[14].

RESULTS AND DISCUSSIONS

All the studied varieties and local types of olive tree were identified with phenotypes obtained by the combination of 15 primary morphological descriptors used relative to characters of the leaf, fruit and the endocarp[14]. For population variety, cultivated under the name of Morrocan Picholine, (Zitoun Beldi, Zitoun El Hor, Zitoun), several individuals were studied in the three prospected regions.

The morphological description of all these individuals revealed the dominance of a standard phenotype represented by the combination (222123212132212), regarding to the 15 studied morphological characters. This phenotype is very common in traditional and ancient olive groves in Ouazzane areas. It is represented by the type of Moroccan Picholine M6 in the region of Masmouda, and the types of Moroccan Picholine S1 and S2 in the region of Sidi Bousber.

The verification of the authenticity of the studied varieties was performed in two steps. The first was the determination of local varieties and types or individuals morphologically different. This discrimination was based on the AFCM performed on the 15 characters retained in the methodology of the primary characterization of olive varieties for their high discriminatory potential[14]. The second step was to compare the 15 varieties characters retained with the descriptions that could be found in the literature[2], from which all data and collected information characterizing each variety and studied local types have been developed (Tableau III). Thus, with the factorial correspondence analysis, we could identify 23 different morphological types on a total of 26 analyzed individuals. The first two axes of the AFCM explained 50.22% of the total inertia (axe 1: 21.76%, axe 2: 18.46%) (Figure: 1).

The morphological contribution of the studied characters to the total inertia varies from character to another. This contribution ranges from 4 to 38% for the fruit form characters. This contribution ranges from 4 to 38% for the maximum diameter of the fruit and the shape of the endocarp, 31% to 38% for the maximum diameter of the endocarp characters, distribution of the endocarp, and the base in position A of the endocarp, was 11% to 12% for the leaf characters.

Relating to the olive tree organs, the discriminating potential of the fruit characters was higher than that of the endocarp and leaf characters. The similarity index of Rogers Tanimoto between local varieties and studied types varies ensue a minimum of 56.66% to a maximum of 100%.

Should be noted that Picual individuals of Ouazzane and Mjaara areas are similar for all 15 discriminating characters. It can be supposed that is the same variety Picual labeled, which was planted in behaviour orchards in both prospected regions whose original plants were provided free as a donation from Spain in 1988, without making the slightest interests to lead the study of its characteristics outside its place of origin (South of Spain) and to evaluate in the same optic the characteristics of its behaviour in the new microclimatic conditions.

Similarly, Ascolana tenera individuals of Sidi Bousber and Ascolana tenera of Ouazzane, are similar for these 15 characters. The same observation is also noted for individuals such Picholine Marocaine M6, Picholine Marocaine S1 and Picholine Marocaine S2.

It is possible to conclude that these 23 different morphological types, leads to the identification of 21 varieties of 24 analyzed varieties, with an identification percentage of 87.5%. The others individuals were grouped into standard type named Moroccan Picholine. Thus, all the traditional varieties, Bouchouk Laghlide, Bouchouk Rkike, Bakhboukh Beldi, Bouchouika, and Dahbia, were identified by a distinct phenotype.

However, we remark the tendency in a morphological resemblance between the two varieties of Bouchouika and Bouchouk Rkike. The morphological differences between them are situated in the level of the characters; initial localization of pigmentation of the pulp, towards the base in Bouchouika and to the apex in Bouchouk Rkike, fruit shape is elongated in Boucouika and ovoid in Bouchouk Rkike. Also, six types of local oleastre were identified by many different phenotypic characters. The morphological description of these types revealed the absence of certain categories of the morphological descriptors. These categories are lanceolate leaf shape, spherical shape of the fruit, nipple of fruit is obvious, maximum diameter position of the fruit and endocarp placed towards the base, forms of the endocarp is spherical and ovoid.

These categories are present in the main Mediterranean varieties and in the Moroccan material studied in this work. The absence of these categories may be linked with the usually small size of fruit organs, endocarp and leaves of the wild forms of the local types.

However, due to the small size of the fruit character, can not be a biggest handicap for their domestication, particularly if we consider that the best oil of the Mediterranean varieties fruits are small size as these are the cases of Arbequina, Mastoidis and Koroneiki varieties[2].

Moreover, the majority of the studied oleasters individuals showed an interesting oil contents, especially types BM2, BMR, BM3, BMM, those gave the oil contents respectively in the order of 23, 76%, 21, 36%, 20.95% and 18.09%. In addition, similar agronomic performances were recorded or are worth mentioning in selected oleaster types in Australia[36].

Furthermore, the confronting results of morphological description of two individuals Picual OU and Picual MJ to the description cited in the literature[4,2] shows that these two individuals are authentic to the Picual variety.

Languedoc Picholine individuals were found authentic in comparison with the results obtained by INRA in Montpellier and by Barranco *et al.* [2,4].

The use of the morphological description results of the Italian varieties established by Cimato *et al.*[12] and Barranco *et al.*[2] shows that the two individuals of Ascolana tenera OU, Ascolana tenera SB and the varieties Cucco and Ascolana dura are genuine.

Similarly, Manzanilla and Gordal individuals have proved authentic by comparing their 15 discriminating characters to characters described by Barranco and Rallo[3] and by Barranco *et al.*[2]. The three individuals named Picholine Marocaine M6, Picholine Marocaine S1, Picholine Marocaine S2, have shown the same basing on the used 15 characters.

For the individuals under the name of Picholine Marocaine in the Mjaara regions, G9, G10 and Masmouda M1, low morphological variability was observed in these types for which the initial colour change was localized to the summit for the Picholine Marocaine Type G10, instead it is to the base, as is the case with the type Picholine Marocaine M1 or regular, as is the case with the kind of Picholine Marocaine G9, in the other hand, these three individuals are different individuals of the Picholine Marocaine M6, Picholine Marocaine S1 and S2, by the character of the endocarp grooves distribution, grouped around the suture in the first group (M1, G9, G10) and regular in the second (M6, S1, S2).

This phenotypic variation, although either small, it confirms the results of morphological characterization and genetic identification of Boulouha *et al.*[9], Lansari[17,18] and Besnard[5], who pointed out that in the name of Picholine Marocaine or Zitoun Beldi detected as a polyclonal variety[5,9] different types under the same denomination have been observed and identified with different morphological characteristics (Zitoun EL Hor, Zitoun Beldi, Zitoun, Zit). Following these results and comparison with the description forms of the studied varieties encountered in the literature[2], we can now confirm the varietal authenticity of the varieties Picual, Picholine du Languedoc, Ascolana tenera, Ascolana dura, Cucco, Manzanille and Gordal.

Besides the standard type of Picholine Marocaine, largely widespread in the three surveyed regions, we could identify other specific types for each of these remote regions. Thus, we identified two types Picholine Marocaine or Zitoun El Hor specific to Mjaara region: G9 and G10, one type of Picholine Marocaine or Zitoun Beldi suitable to the Masmouda region: M1.

Similarly, six local types of wild olive were identified. These types are BM4, BMM and BMR, proper to the Mjaara region and any types represented by BM2, BM3, and BMK, appropriate to the Masmouda region. The identification of these individuals among both oleasters than in cultivated types present in Ouazzane, mountainous region in continuity with other regions of north Morocco, shows the originality and the particularity of certain and real populations, individuals of the wild oleasters and of the obtained Picholine Marocaine, as well as the ancient local cultivated varieties, existing in some remote localities at the heart strings of the Prerif zone, looted and introduced by human or endemic, because the size of fruits of these oleasters are small with a low oil content, especially those in the high altitudes regions, that do allow prompt utilization as a therapeutic using by local peoples for therapeutic and medicinal potential virtues of their oil and with peculiarities qualitative characteristics that could provide a variety of production.

The cluster analysis (CHA) has defined and distinguished six groups of varieties and local types in the agglomeration level 75% of similarity (Figure : 5).

Group I is composed by local varieties (Bouchouk Laghlide, Bouchouk Rkike, Bouchouika). These varieties are characterized by a nipple (tenuous, obvious), initial location of colour evolution (apex, uniformly, basis), shape of the endocarp (spherical, elongated), A symmetry position of the endocarp (slightly asymmetric, asymmetric), and the base of the endocarp (pointed, truncate).

Group II includes all types of the Picholine Marocaine (M1, M6, G9, G10, S1, S2), the wild olive type (BMK, BMM), the autochthonous variety Bakhboukh Beldi, and the foreign variety Gordal. Morphological characteristics that distinguish these local varieties and types are : leaf shape (elliptic-lanceolate), fruit shape (spheric, elongated), maximum diameter of the fruit (to the base), initial location of colour change (from apex, from the base), shape of the endocarp (elongated), maximum diameter of the endocarp (towards the base), summit the endocarp (rounded) and base of the endocarp (pointed, truncated).

Group III includes foreign variety Picual of the regions of Mjaara and Ouazzane, these individuals have in common morphological traits used to discriminate between the studied local varieties and types.

Group IV is comprised of the traditional variety (Dahbia) and 3 foreign varieties (Picholine du Languedoc, Ascolana tenera, Cucco). This group is characterized by leaf shape (elliptic-lanceolate, lanceolate), fruit shape (elongated), nipple (tenuous), form of the endocarp (elongated) and base of the endocarp (pointed, truncated).

Group V, contains mainly wild olive type (BM2, BM4), which is characterized by the leaf shape (elliptic, elliptic-lanceolate), fruit shape (elongated), shape of the endocarp (elongated), maximum diameter of the endocarp (central, towards the base), the base of the endocarp (pointed, rounded).

The last group (group VI) gathers wild olive type (BM3, BMR) and foreign varieties (Ascolana dura, Manzanille). The characteristics of this group are: leaf shape (elliptic), fruit shape (spheric, ovoid, elongated), maximum diameter of the fruit (towords the base), initial localization of evolution colour (towards the base), shape of the endocarp (ovoid, elongated), and maximum diameter of the endocarp (towords the base).

Moreover, we note that most of the Mediterranean varieties, originated from Spain, Italy, and France, are grouped in groups IV and VI and the large majority of the Moroccan varieties and local types have a local geographic distribution, is grouped in the groups I and II. This resemblance proves a possible related relationship, in spite of the genetic diversity of the studied material. This is in agreement with the fact that different individuals of each locality are close geographically and genetically close and they may have a common origin.

Inter fertility, so special, between two olive compartments, wild and cultivated, coexisting in sympatric and predominantly outcrossing of the millennium species, cause it is subject to frequent exchanges or genetic intermingling and shared the same gene pool between wild and the cultivated type. In other words, the clones of the cultivated olive tree (which bloom every year and produce an enormous quantity of pollen, compared to the wild forms), could have heavily polluted the integrity of the wild olive populations over the millennia, even if this could be limited to the level of a generation (flow of interpopulations genes and between individuals). This has contributed to the creation of the largest diversity of trees stands. Spontaneous mutations (latent and beyond the control of the home), will also appear in different olive tree clones, and the propagation of this material may lead to the development and distinction of new varieties[5,11].

Native results of this work and for all the Moroccan material show low morphological variability with very prominent standard type everywhere, at both of the types Picholine Marocaine and old local cultivated varieties than oleasters.

Polymorphism stands of wild olive and types of the Picholine Marocaine, has continued to the present day due to the low pressure of human selection. However, this sampled material, requires further and additional agronomic studies combining the results of analyzes of multiple nuclear genetic traits, cytoplasmic, chloroplastic and ribosomal (genetic and molecular markers).

The advanced hypothesis, that there is a truly wild component in Morocco, seems to be confirmed and the oleaster didn't derive exclusively from cultivated material cloned haphazardly and are evidence of the survival of the indigenous wild populations to the surveyed regions[37].

Where an urgent demand, that the conservation of genetic resources of the olive tree before critical extinction programmed (germplasm), might also relate to the wild, endemic trees and even related species, to evaluate the genetic potential of the olive tree (wild and cultivated). This taxon is interesting for its resistance to drought or for use as rootstock in the arid zone and hotter environmental conditions.

Finally, it would be interesting to carry out programmes for the genetic improvement of olive tree by crossing (outcrossing, directed or controlled), to take advantage of the richness of available and usable genetic resources, especially in wild forms and in related species, often considered as agronomically less interesting, and certainly represents a rich genetic heritage, potentially useful for the improvement of the cultivated olive, but their exploration is not optimal and may therefore require to perform other investigations, in order to get maximum diversity, existing source of variability in landraces and their wild populations, and to choose the best variety preferred for the establishment of a new olive orchards.

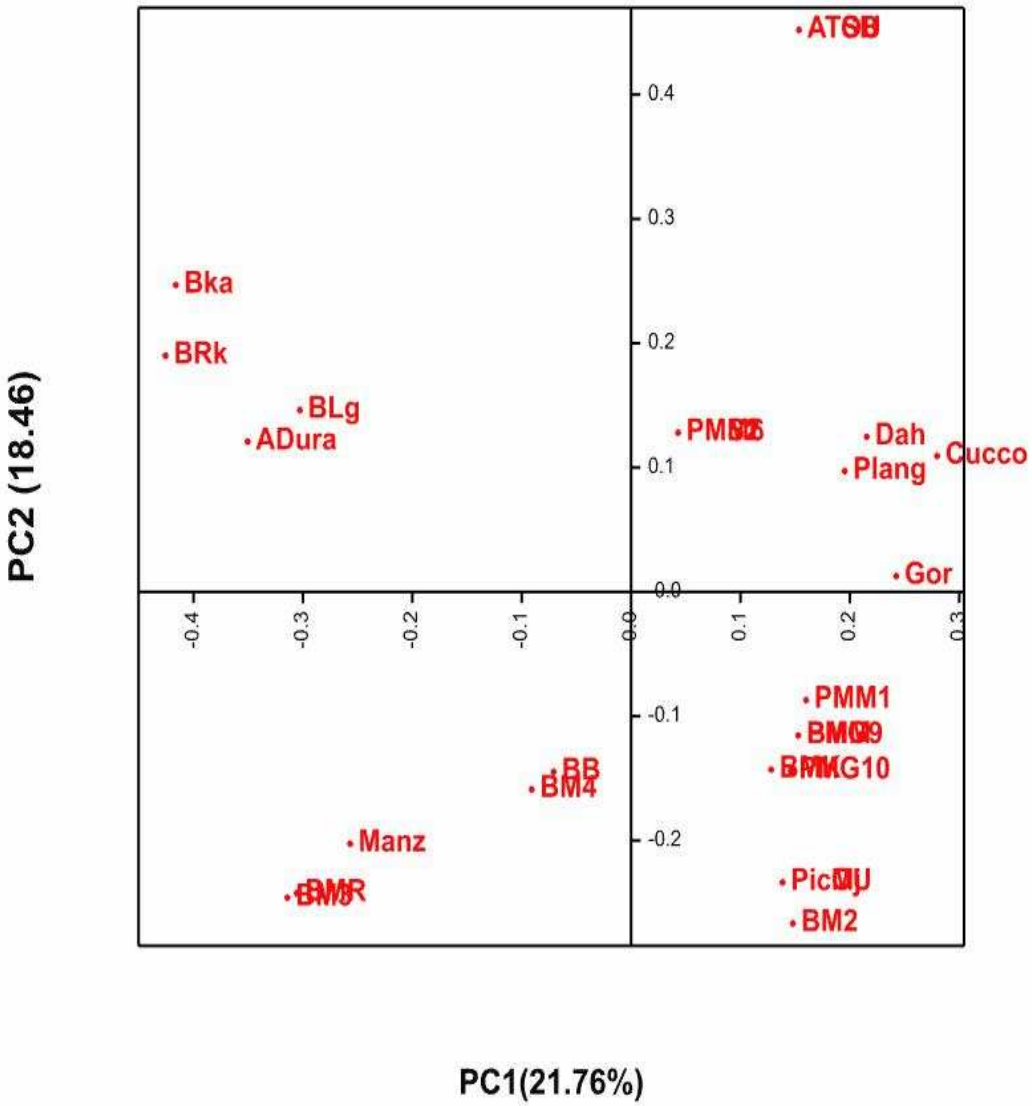
Their preservation and protection is a big challenge that inspired future generations, including the fight against desertification and climate aridity and meet their own needs of rural development, to improve the positive impact on the ecological environment, social life and territories landscape conservation.

CONCLUSION

The genetic diversity of the olive (biodiversity) in the Ouazzane region was characterized by the use of 15 morphological characters with a high discriminatory potential. Specific local types of the population named Moroccan Picholine 'Picholine Marocaine' variety and appropriate wild olive for each region were identified.

The multitude authenticity a of local and foreign studied varieties was approved for the safeguard of olive germplasm. Thus, the richness of genetic resources might be conserved and preserved in the aim of improving the cultivated olive tree in breeding purposes (outcrossing or directed), but their total exploration is not fully achieved and requires further inquiries and investigations. So they could represent a very important resource for an optimal evolution of the olive sector in the future. It would also be useful to extend the investigation to minor varieties which could have particularities useful (table olive, oil characteristics, resistance to biotic and abiotic stresses). It is interesting to combine morphological and genetic markers for the identification and reliable description, evaluation of the genetic potential and certification the genetic identity of the varieties, local wild and cultivated olive and characterization and labeling for product quality of monovarietal olive oil produced in each surveyed region.

Fig.1: Representation of the studied local varieties and types in the first two axes of the MCA



Hidden points are; ATOU by ATSB, Pic MJ by Pic OU PMS1, PMS2 by PMM6, BMM by PMG9, BMK by PMG10, BM3 by BMR

Fig.2: Dendrogram resulting from the hierarchical clustering analysis (CHA) representing the phyllogenetic relationships between 26 studied local varieties and types

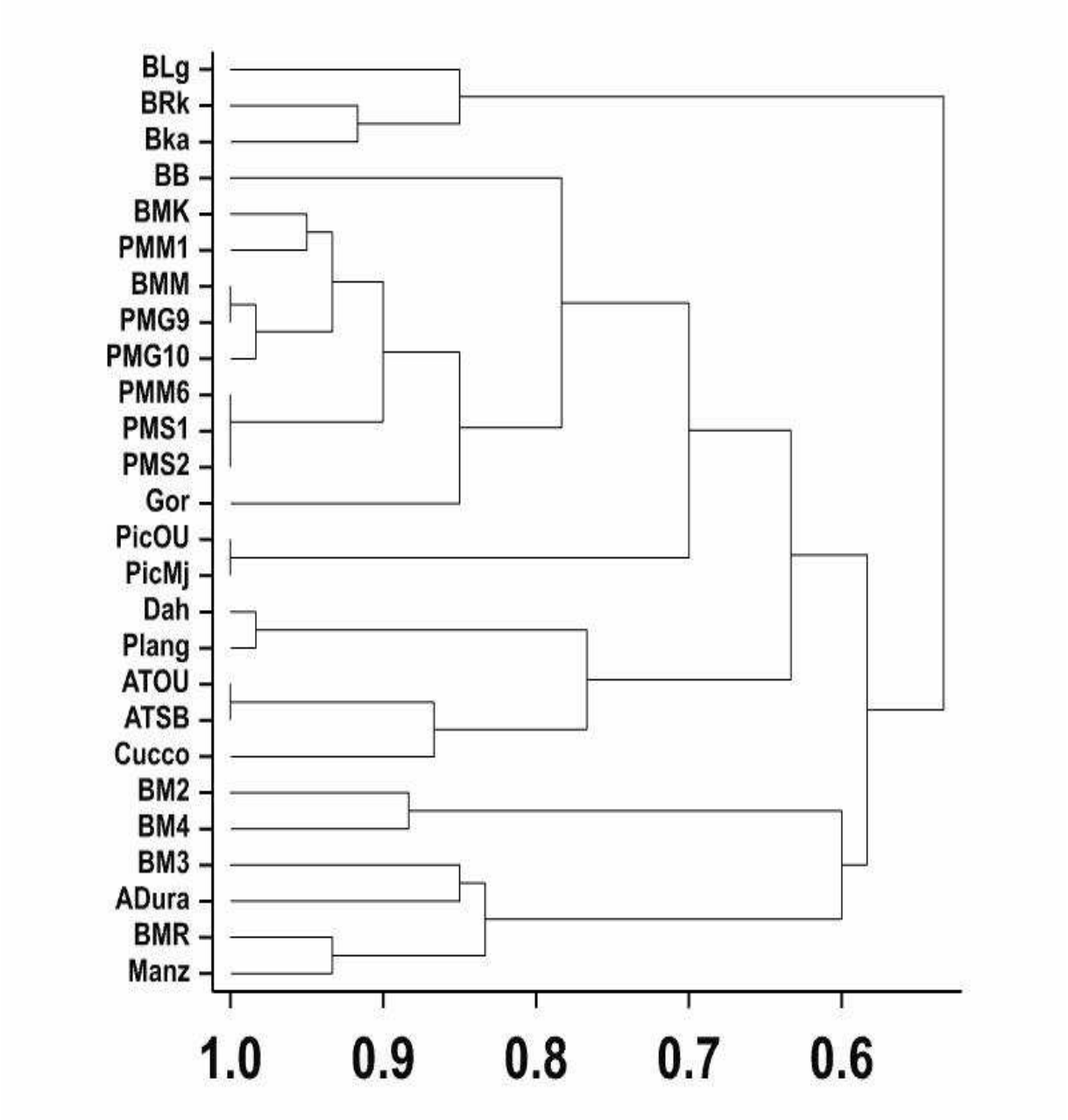


Table III: Description forms (multi characters phenotypes) of the studied Moroccan traditional varieties, local types and foreign varieties

Varieties and Local	FFE	FFR	DMF	Mam	LIV	FOE	SAE	SBE	DIE	STE	BAE	SUE	NSE	DSE	Muc
B.Laghlide	2	3	3	2	2	4	2	1	3	1	3	2	2	1	2
B.Rkike	2	2	3	3	3	3	3	1	3	1	2	2	2	1	2
B.Beldi	2	2	2	3	2	3	2	1	2	2	3	2	2	2	2
Bouchouik	2	3	3	3	1	3	3	1	3	1	2	2	2	1	2
BM2	1	3	2	1	2	4	2	1	2	1	2	1	1	2	1
BM3	1	3	3	1	2	3	2	1	3	2	3	2	2	2	2
BMK	1	3	2	1	2	3	2	1	2	1	3	2	2	2	2
BM4	2	3	2	1	2	4	2	1	3	1	1	1	2	2	1

BMR	2	2	3	1	3	3	2	1	3	2	2	2	1	2	2
BMM	2	2	2	1	2	3	2	1	2	1	3	2	2	2	2
PMM1	2	2	2	1	1	3	2	1	2	1	3	2	2	2	2
PMM6	2	2	2	1	2	3	2	1	2	1	3	2	2	1	2
PMG9	2	2	2	1	2	3	2	1	2	1	3	2	2	2	2
PMG10	2	2	2	1	3	3	2	1	2	1	3	2	2	2	2
PMS1	2	2	2	1	2	3	2	1	2	1	3	2	2	1	2
PMS2	2	2	2	1	2	3	2	1	2	1	3	2	2	1	2
Dahbia	3	3	2	2	2	4	2	2	2	1	2	1	2	2	2
P.Languedoc	2	3	2	2	2	4	2	2	2	1	2	1	2	2	2
Picual OU	2	2	2	1	3	3	3	1	2	1	3	3	2	2	1
Picual MJ	2	2	2	1	3	3	3	1	2	1	3	3	2	2	1
ATeneraOu	2	2	2	1	2	3	2	2	2	1	1	3	3	1	2
ATeneraSB	2	2	2	1	2	3	2	2	2	1	1	3	3	1	2
A Dura	2	2	2	1	2	3	2	1	3	2	2	2	3	1	2
Gordal	3	2	1	1	1	3	2	1	2	1	2	3	2	2	2
Manzanille	2	1	2	1	3	2	2	1	3	2	2	2	2	2	2
Cucco	3	2	2	1	3	3	2	2	2	1	2	3	2	2	2

REFERENCES

1. Akerraz, A. and Lenoir, M. L'oléiculture dans le Maroc antique. Olivae 3,12-17 (1984)
2. Barranco, D. Cimato, A. Fiorino, P. Rallo, L. Touzani, A. Castaneda Cserafini, F. Trujillo, I. Catalogue mondial des variétés d'olivier. COI.Madrid.1-360 (2000)
3. Barranco, D. and Rallo, L. Las vriedades de olivo cultivadas en Andaloucia. Consejeria de la junta d'Andalooucia. MAPA. Madrid. 387 (1984)
4. Barranco, D. and Rallo, L. Les variétés d'olivier cultivées en Espagne. Olivae **6**:16-20 (1985)
5. Besnard, G. Génétique et évolution des plantes en milieux méditerranéen et tropical Thèse de Doctorat. Université des Sciences et technologies de Lille (France) 42 (2009)
6. Besnard G., Baali-Cherif D., Bettinelli-Riccardi S., Parietti D., Bouguedoura N., Flux de pollen dans un habitat hautement fragmenté : Conséquences pour la conservation des populations reliques d'olivier de Laperrine. Comptes Rendus biologies, **332(7)**: 662-672 (2009)
7. Boulouha, B. Croissance, fructification et leur interaction sur la production chez la Picholine Marocaine. Olea n°17, 41-47 (1986)
8. Boulouha, B. Contribution a l'amélioration de l'olivier (*Olea europaea* L.) variété Picholine Marocaine par la sélection clonale dans la région du Haouz. Mémoire d'ingénieur en chef - INRA de Marrakech - 63 (1991)
9. Boulouha, B. Etude de la variabilité phénotypique de la variété population Picholine Maraocaine dans la région du Haouz. Olivae n° 4, 30-33 (1992)
10. Boulouha, B. Loussert, R. Saadi, R. Etude de la variabilité phénotypique de la variété Picholine marocaine dans la région du Haouz ; 0livae n° 48-Octobre. (1992)
11. Boulouha, B. Apport de la sélection clonale à la certification des plants d'olivier. Séminaire international sur la multiplication et certification des plants d'olivier, un nouvel enjeu pour l'oléiculture du 3ème millénaire.2-7Avril, ENA Meknès (Maroc) (2001)
12. Cimato, A. Les ressources génétiques comme instrument d'optimisation de la production. Olivae N°73, 45-49 (1999)
13. COI. Méthodologie pour la caractérisation primaire des variétés d'olivier. Projet RESGEN-CT (67/97), Union Européenne/COI. (1997)
14. COI. Méthodologie pour la caractérisation secondaire des variétés d'olivier en collection. Projet RESGEN-CT (67/97), Union Européenne/COI. (1997)

15. COI. Norme commerciale applicable aux huiles d'olive et aux huiles de grignons d'olive.T.15/NC n°3/ Rév.4 (2009)
16. Hauville, A. La répartition des variétés d'olivier en Algérie et ses conséquences pratiques. Bull. Soc. Agric. Algérie, **580**: 1-8 (1953)
17. Lansari, A. and Tahri, H. Contribution à l'étude de la variabilité morphologique au sein de populations de Picholine Marocaine dans la région de Zerhoun au Maroc. Olivae n°60, 42-47 (1996)
18. Lansari, A. Diversité génétique locale de l'olivier : Réservoir pour la sélection. La recherche agronomique et la profession, ensemble pour un développement durable de l'oléiculture nationale. Journée olivier.26 décembre. Meknès (Maroc) (2006)
19. Maestratti, I. L'oléiculture dans la région de Fès. Actes du Vaine congrès international d'oléiculture, 96-119 (1922)
20. Maillard, R. L'olivier- document INVUFLEC-146 (1975)
21. Moundi, E.M. Contribution à l'étude de l'amélioration de l'olivier .Possibilité de sélection clonale, étude variétale. Mémoire de 3ème cycle INAVHII ; RABAT (1974)
22. Moundi, E.M. and Bouzroud, H. Etude du comportement de 40 variétés d'oliviers à la station expérimentale de la Menara, Séminaire international sur la culture intensive de l'olivier.Marrakech. 75-84 (1981)
23. Moundi, E.M. and Bouzroud, H. Résultats de l'étude de comportement de 40 variétés d'olivier à la station expérimentale de la Ménara.AlAwamia, n°68, 58-80 (1990)
24. Ouazzani, N. Etude de la variabilité des ressources génétiques de l'olivier (*Olea europaea* L.) à l'aide du polymorphisme enzymatique.Thèse de doctorat es-sciences agronomiques.IAV Hassan II Rabat (Maroc) (1993)
25. Ouazzani, N. Lumaret, R. and Villemur, P. Genitic variation in the olive tree (*Olea europaea* L.) cultivated in Morocco. Euphytica **91**: 9-20 (1996)
26. Ouazzani, N. Lumaret, R. Villemur, P. Utilisation des marqueurs génétiques pour l'identification et l'évaluation de la diversité génétique de l'olivier (Olea europea L). 6ième journées scientifiques du réseau biotechnologiques végétales. AUPELF, Orsay. Juillet, 421-426 (1997)
27. Ouazzani, N. Idrissi, A. Belkoura, I. Sghir, S. Caractérisation génétique, morphologique et évaluation agronomique : Apport à la certification des plantes d'olivier. Séminaire Internationale sur la multiplication et la certification des plants d'olivier, un nouvel enjeu pour l'oléiculture du 3ème millénaire.2-7 Avril ; Meknès(Maroc), 118-193 (2001)
28. Ouazzani, N. Lumaret, R. Idrissi, A. El Ghazi, N. Varietal structure of Moroccan Olive germoplasm: evidence from genetics markers and morphological characteristics. Acta Horticultae **586**: 233–236 (2002)
29. Ouazzani, N. Etat actuel des connaissances des ressources génétiques de l'olivier au Maroc.2ème édition des journées méditerranéennes de l'olivier.22-26 Octobre.ENA Meknès (Maroc) (2007)
30. Ouazzani, N. Etat actuel des connaissances des ressources génétiques de l'olivier au Maroc.3ème édition des journées méditerranéennes de l'olivier. 27-29 Octobre, ENA Meknès (Maroc) (2008)
31. Rallo, P. Intégration des marqueurs moléculaires et morphologiques dans l'identification variétale. Séminaire International sur les ressources génétiques de l'olivier. 1-3 Décembre, Marrakech (Maroc) (2008)
32. Ruby, J. Recherches morphologiques et biologiques sur l'olivier et ses variétés cultivées en France.Thèse.Faculté des sciences de Paris (1918)
33. Trigui, A. Ressources génétiques et sélection variétale de l'olivier: Cas de la Tunisie. Séminaire international sur la multiplication et certification des plants d'olivier, un nouvel enjeu pour l'oléiculture du 3ème millénaire.2-7Avri, ENA Meknès (Maroc) (2001)
34. Trigui, A. Ressources et amélioration génétique de l'olivier : Etat de recherche en Tunisie.Séminaire international sur l'oléiculture : Acquis de recherches et Contraintes du secteur. 14-17 Mars. Marrakech (Maroc) (2002)

35. Tornezy, M. Pour l'olivier; compte rendu du Vième congrès Int. Oleic. Marrakech-Rabat 26-11 au 10-12.Maurice Mendel. Ed.400 (1922)
36. Wirthensohn, M. Burr, M. Granger, A. Jones, G. Sedgley, M. Sélection en Australie d'oléastres produisant des huiles de qualité supérieure.Olivae n°87, 39-43 (2001)
37. Zohary, D. Spiegel-Roy, P. Beginings of growing in the old Word. Science **187**: 319-327 (1975)