

# Elaboration of a key to the determination of indigenous figs in North-West Morocco

El Oualkadi A\*, Hajjaj B\*

\*INRA- Regional Agricultural Research Center of Tangier, Morocco

Corresponding author. E-mail: [ai.oualkadi@gmail.com](mailto:ai.oualkadi@gmail.com)

**Abstract**— Morocco, with its pedoclimatic potential, is a natural habitat for the fig tree, especially the autochthonous fig tree where the genetic diversity remains to be highlighted. In this work a study has been made of the characters that best differentiate autochthonous figs from northwestern Morocco. To establish our determination key, we proceeded to a hierarchy of characters to use. For this, we have based essentially on the practical aspect of the characters, that is to say the characters easy and obvious observation and whose different states are also easy to observe and appreciate.

**Keywords**— *Ficus carica L.*, Northwest Morocco, indigenous, key determination.

## I. INTRODUCTION

The fig (*Ficus carica L.*) may be the first domesticated plant of the Neolithic Revolution [1]. It is considered to have been cultivated for the first time in southern Arabia [2]. Wild or "almost wild" figs have been reported throughout much of the Middle East and Mediterranean region [3]. Today, it is cultivated worldwide, with a production rate of one million tones [4].

At the national level, the fig tree is a tree of great importance for the Moroccan population and fulfills several functions: social, economic and environmental [5]. Northern Morocco is characterized by a heterogeneous physical environment (climate, soil, relief, land use ...) [6]. It is a hot spot area for biodiversity in the Mediterranean region [7]. Demographically, it is the most populous region of the country [8].

Cultivation of the fig tree, of which 85% of the national orchard is located in the Rif, is the best illustration of such a situation. However, despite the maintenance of traditional survival agriculture, fruit trees and in particular fig trees represent a secondary agricultural activity threatened with marginalization. Local varieties of the fig tree maintained under ecological conditions and in areas with contrasting farming practices are probably characterized by high genetic diversity and considerable hardiness. Morphology, pomology and molecular markers are effective tools for assessing genetic diversity and classifying fig accessibility surveys for plant diversity, but these traits are strongly influenced by environmental conditions. To remedy this, a wide range of molecular markers is increasingly used to evaluate genetic polymorphism. Unfortunately, little research has been done on genetic diversity in fig genetic material [9]; [10];

[11]; [12]; [13]; [14]. To better conserve and use genetic resources, patterns of characterization of morphological variability within collections and selection of the most significant variables must be carefully performed [11]. In Morocco, apart from the work done on the Aïn Taoujdate domain collection at INRA Meknes [15], [16]. The Aïn Taoujdate varietal collection is considered as a reference collection for fig tree genetic resources in Morocco and is also the only collection analyzed and characterized at the pomological and molecular level [15]; [16]. Unlike other fruit trees, on the fig tree no work on the establishment of a determination key has been made. The development of determination keys using statistical programs [17] and automatic measurement methods by computer to obtain data in a fast and accurate manner [18]; [19] have thus been made possible. For example, for the vine species close to the fig tree, the use of computers and the generalization of computers have greatly favored the production of ampelographic files for the recognition of grape varieties [20]; [21]; [22], [23]; [24]; [25]; [26] [27]; [28]. In this work, we have mainly sought to differentiate autochthonous figs from northern Morocco and to develop a key to determine these figs based on pomological criteria.

## II. MATERIAL AND METHODS

### *Plant material*

The study looked at 96 ecotypes of fig trees prospected in northern Morocco. It is about 49 indigenous figs, well spread in the orchards of northern Morocco (Table.1). The work was based mainly on surveys carried out in 14 stations in four large areas in the north - west of the

country. These stations were chosen according to the importance of fig orchards in agrosystems (Fig. 1).

- Béni Ahmed area: characterized by its richness in fig and caprifigue as well as a good knowledge of cultivation techniques in particular caprification.
- Areas of Moukrisset, Zoumi and Oued Laou: areas rich in figs with very diversified varieties, but with a lack of knowledge of caprification techniques.
- Khmiss anjra area: is a new and much diversified variety of resources especially in Douar Tafza, this area is also characterized by a neglect of caprification.

Table.1: List of varieties studied

The main varieties		
Rhoudane	Saadi	Jouhri
Gaouizi	Lemti	Ournakssi
Ferzaoui	Sinani	Kharar
Baghi assal	Achir	Hafer elbrel
Harchi el khal	Hafri	Sbaa ou rhgoud
Meltoufa	Chitoui	Kohli
Kharaza	Bakour	Zerki
Tahadakte	Larchan	Tbantou
Tabli	Mouslikh	Sibti
Hazouta	aroui	Kourti
Lmdar	L'khoubiz	Silfaf
L'hmar	Lndbar	Smouni
Fassi	L'beidi	Khoumsi
El messari	harchi lbeid	Ounk Hmam
Makoutia	L'mdar eL khal	Ozilane
Qouti	Maalmouss	
Lassoune	Zenfoukh	

#### Statement of determination key:

To establish our determination key test, we proceeded to a hierarchy of characters to use. For this, we have based essentially on the practical aspect of the characters, that is to say the characters easy and obvious observation and whose different states are also easy to observe and appreciate.

So we adopted the following hierarchy to build our key:

**A: Color of the epidermis.**

**B: Form of the fruit.**

**C: Type of collar.**

**D: Peduncle.**

**E: Cracks.**

**F: Form of the top of the fruit.**

**G: Ostiole.**

**H: Placenta.**

The combination of these different characters allows us to make a satisfactory distinction of the varieties prospected during our study.

### III. RESULT AND DISCUSSION

For the establishment of this key of determination, several problems arise which one can quote:

1 / Varieties such as: Kohli, Fassi, Ounq Hmam, Gaouzi, Koti, meet several definitions and are repeated in the descriptive sheets with different characters,

2 / Varieties that are considered both unified and biferous as Assal, Kohli, Koti, and Ounq hмам.

These various problems are due to several causes, on the one hand the insufficiency of the repetitions within each variety, to have an idea on the variability intra varietal, and on the other hand to the limited and probably very local value of the the same variety may have different names in two different localities, such as the case of the variety El messari which bears this name in the region of Beni Ahmed while the same variety is named Johri in the region of Moukrisset. There is also the problem of varietal knowledge among respondents, who may confuse varieties or who disagree about variety traits. Indeed, the same variety can be considered fig with tow production by a person while for another person it will be of fig of one production.

**Key for the determination of autumn figs****1. Fig with one production**

- A. Purple epidermis black to black
  - B. Flattened pyriform fruit to oblic turbiform
  - C. Col absent
    - D. Long and thin peduncle, little pubescent skin
      - F.F. Rounded Summit.....1- Gaouizi
    - D.D. Short and thick peduncle
      - G. Ostiole small half open with a split .....2.Tahadakte
      - G.G Ostiole large, open without splitting ..... 3.El Smouni
    - C.C. Prominent collar .....4- Gaouizi
  - B.B. Short pyriform fruit
    - C. Col absent
      - D. Thick and long peduncle, little pubescent skin ..... 5- Harchi lkhal
    - B.B.B. Flattened spherical fruit, very delicate and non-pubescent skin ..... 6- Tabli
    - B.B.B.B Small fruit, elongated pyriform ..... 7.Assal
- A.A. Light green epidermis, yellow green, sometimes dark green
  - B. Elongated pyriform fruit, sometimes oblique
    - D. Short and thick peduncle
      - E. Small longitudinal cracks and tight furrows
        - G. rounded apex ..... 8- Chitoui
        - G.G. flat top ..... 9- Sbaâ or R'koud
      - E.E Fissures absent, and longitudinal furrows of minor importance ..... 10- Harchi lbyad
  - B.B. Flattened spherical fruit
    - C. Col absent
      - D. Short and thick peduncle
        - E. Cracks present
          - G. Fine paths ..... 11. Herich
          - G.G Furrows big ..... 12. Zenfough
        - E.E. Missing cracks
          - G. Strong furrows well marked ..... 13. Koti
      - D.D. Long and thin peduncle, dark green .....14. Khoumsi
    - B.B.B. Small, flattened or turbidiform pyriform fruit
      - C. Col absent
        - E. Missing cracks ..... .15. Bakour
        - E.E. Small cracks ..... 16. Kohli
      - C.C. Thick collar
        - F. Few furrows and whitish spots .....17 Larchan
        - F.F Fine creases, yellowish spots ..... 18 Koti
  - B.B.B.B. Fruit of small size elongated pyriform ..... 19 Ounq hmam
  - A.A.A. Epidermis red brown to black
    - B. Flattened spherical fruit
      - C. Col absent
        - H. Fruit de très grande taille sans tâches,
          - G. Placenta blanc jaunâtre .....20. Mouslikh
        - H.H. Fruit de petite taille, avec des taches importantes
          - G.G. Placenta blanc verdâtre.....21.Kharaz
      - B.B. Fruit de petite taille, pyriforme aplati
        - C. Col absent.....22 Ounq hmam

C.C. Col épais.....	23.Kourti
A.A.A.A. Epiderme jaune doré, parfois de couleur rose jaune très caractéristique du fruit.....	24. Silfafa
C. Col absent	
H. Very large fruit without stains,	
G. Yellowish white placenta .....	20. Mouslikh
H.H. Small fruit, with important spots	
G.G. Greenish white placenta .....	21.Kharaz
B.B. Small fruit, flattened pyriform	
C. Col absent .....	22 Ounq hmam
C.C. Thick col .....	23.Kourti
A.A.A.A. Golden yellow epidermis, sometimes of a yellow pink color very characteristic of the fruit .....	24. Silfafa

## 2. Fig with two production

A. Reddish brown epidermis	
B. Flattened pyriform fruit	
C. Very long neck more or less thick	
D. Short and thick peduncle, not very delicate skin	
G. Flat Summit .....	25- Zerqui
C.C. Col. more or less long	
D.D. Short and thick peduncle, very delicate skin	
G.G Rounded Summit .....	26- Baghi
C.C.C. Col absent	
Short and thick peduncle	
E. Not very delicate skin	
G. Half open ostiole .....	27. Assal
G.G. Ostiole closed	
H. Yellowish white placenta .....	28. Harchi
H.H. Greenish white placenta .....	29. Kohli
C.C.C.C. Thick neck flattened	
D. Long and thin peduncle .....	30- The mti
B.B. Flattened spherical fruit	
C. Col absent	
D. Short and thick peduncle .....	31. Hafer el bghal
D.D. Long and thin peduncle	
F. Missing cracks .....	32.Hamra
F. F. Small longitudinal cracks .....	33. Fassi
C.C. Long, thick neck, thin on the side of the peduncle like the pigeon's neck .....	34. Ounq hmam
C.C.C. Very short neck almost absent	
Epidermis with yellowish, elongated, brownish patches .....	35.Hmir
C.C.C.C. Thick and short collar	
Epidermis with few brown spots .....	36. Lmdar lkhal
C.C.C.C.C. Thick neck long and flattened	
Small flattened spherical fruit is consumed when it is still green .....	37.Makoutia
B.B.B. Globular spherical fruit and absent collar .....	38. Ounq hmam
B.B.B.B. Short pyriform fruit of average size .....	39. Tbantou
B.B.B.B.B. Fruit short or globose pyriform .....	40. Fassi
B.B.B.B.B.B. Extended pyriform fruit .....	41. Hafri
A.A. Epiderme vert clair à vert jaune	

B. Fruit sphérique aplati	
C. Col absent	
D. Pédoncule court et épais	
F. Fissures de faible importance.....	42.Lmdar lbyad
F.F. Fissures absentes	
H.Ostiole demi ouvert.....	43.Maalmnouss
H.H. Ostiole fermé.....	44.Lassoun
D.D. Pédoncule long et mince.....	45.Koti
C.C. Col épais et petit	
B.B. Fruit turbiniforme oblique.....	46.Lndbar
A.A. Light green to yellow green epidermis	
B. Flattened spherical fruit	
C. Col absent	
D. Short and thick peduncle	
F. Small cracks .....	42.Lmdar lbyad
F.F. Missing cracks	
H.Ostiole half open .....	43.Maalmnouss
H.H. Ostiole closed .....	44.Lassoun
D.D. Long and thin peduncle .....	45. Koti
C.C. Thick and small collar	
B.B. oblique turbiniform fruit .....	46.Lndba
B.B.B. Pyriform fruit, flattened	
C. Short and thick neck	
F. Fissures absent, well marked furrows	
G. Delicate and pubescent skin .....	47.El messari
G.G. Skin not very delicate and pubescent .....	48 Gaouizi
F. Fissures absent, furrows in the form of abundant plumes, especially when the fruit is touched .....	49.Ournakssi
C.C. Thick neck long and flattened .....	50.Saadi
C.C.C.Col absent	
D. Short and thick peduncle	
H. Large fruit with long brown spots .....	51.Sebti
D.D. Long and thick peduncle	
H. Small fruit with yellowish spots .....	52.Sinani
B.B.B.B. Small fruit, oblique pyriform .....	53.Harchi lbyad
B.B.B.B.B. Very small fruit, very pigmented with yellowish spots .....	54.Achir
A.A.A. Black epidermis	
B. Small fruit, flattened pyriform or oblique turbiniform	
C. Short and thick neck	
F. Fissures absent, well marked furrows	
G. Yellowish white placenta .....	55.Assal
F.F. Small cracks	
H. Not very delicate skin .....	56.Kohli
F.F.F. Longitudinal cracks	
H.H. Very delicate skin .....	57. Rzilane
C.C. Thick and long neck	
H. Flat top .....	58. Harchi lkahl
H.H. Rounded summit .....	59. Baghi
C.C.C. Thick and thin collar .....	60. Ferzaoui
C.C.C.C. Col missing .....	61. tibal
B.B. Small flat spherical fruit	

- D. Short and thick peduncle
  - H. Rounded Summit ..... 62. Gaouzi
  - H.H. Flat top .....63. Meltoufa
- B.B.B. Elongate pyriform fruit of medium size, sometimes oblique turbiniform
- C. Col absent
  - D. Short and thick peduncle
    - F. Small cracks
      - G. Flat Summit ..... 64. Aroui
- D. Short and thick peduncle
  - H. Skin not very delicate, pubescent ..... 65. Humoubiz
  - H.H. Skin not very delicate and not pubescent, smooth ..... 66. Hazouta
  - F.F Longitudinal cracks well marked .....67. Ghouddane

#### IV. CONCLUSION

The method used proved to be very useful in differentiating autochthonous fig tree varieties from northwestern Morocco. Classical morphological description is still the method most used in a practical way by a large number of people. The most discriminating characters are, ultimately, those that express the color of the epidermis, the shape of the fruit, the type of cervix, the peduncle, the cracks, the shape of the top of the fruit, the ostiol and the placenta because it allows to qualify the variables and gives us an exact idea of the different degrees taken by the parameters. The use of fig determination keys, from these parameters seems valid for a zone or a region delimited with a number. To improve the quality of this key, it would be necessary to increase the number of observations and to widen the surveys in order to have a clear vision on the different varieties. This pomological approach will be complemented by the use of molecular markers.

#### ACKNOWLEDGMENT

The authors are grateful to all farmers for providing necessary facilities for conducting this research work.

#### REFERENCES

- [1] Kislev ME, Hartmann A, Bar-Yosef O (2006) Early domesticated fig in the Jordan Valley. *Science*. <https://doi.org/10.1126/science.1125910>.
- [2] Storey WB (1975) Figs. In: Janick J, Moore JN (eds) *Advances in fruit breeding*. Purdue Univ. Press, West Lafayette, pp 568–589.
- [3] De Candolle A (1886) *Origin of cultivated plants* (reprint of 2nd edition, 1967). Hafner Publishing, New York.
- [4] FAOSTAT (2012) Food and Agriculture Organization of the United Nations Statistics for 2012. [http://www.fao.org/faostat/en/#rankings/countries\\_by\\_commodity](http://www.fao.org/faostat/en/#rankings/countries_by_commodity). Accessed 14 Nov 2018.
- [5] El Bouzidi S. (2002). Le figuier: histoire, rituel et symbolisme en Afrique du Nord. *Dialogues d'Histoire Ancienne* 28:103-120.
- [6] El Gharbaoui A. (1987). La terre et l'Homme dans la péninsule tingitane : étude sur l'homme et le milieu naturel dans le Rif occidental. Travaux de l'Institut Scientifique. *Série géologie et géographie physique*, N°15, Rabat, Maroc, 439p.
- [7] Médail F. and Quézel P. (1999). Biodiversity Hotspots in the Mediterranean Basin: Setting Global Conservation Priorities. *Conservation Biology* 13:1510-1513.
- [8] Anonyme. (2003). Direction de la statistique : Annuaire statistique du Maroc. Royaume du Maroc, Haut Commissariat au Plan.
- [9] Aksoy U, Can HZ, Misirli A, Kara S, Seferoglu G, Sahin N (2003). Fig (*Ficus carica* L.) selection study for fresh market in Western Turkey. *Acta Hort* 605: 197-203.
- [10] Stover E, Aradhya M (2008). Fig genetic resources and research at the US National Clonal Germplasm Repository in Davis, California. *Acta Hort* 798: 57-68.
- [11] Giraldo E, Lopez Corrales M, Hormaza JI (2010). Selection of the most discriminating morphological qualitative variables for characterization of fig germplasm. *J Amer Soc Hort Science* 135: 240-249.
- [12] Podgornik M, Vuk I, Vrhovnik I, Mavsar DB (2010). A survey and morphological evaluation of fig (*Ficus carica* L.) genetic resources from Slovenia. *Sci Hort* 125: 380-389.
- [13] Şimşek M, Yildirim H (2010) Fruit characteristics of the selected fig genotypes. *Afr J Biotechnol* 9: 6056-6060.
- [14] Dalkılıç Z, Mesav HO, Günver-Dalkılıç G, Kocataş H (2011). Genetic diversity of male fig (*Ficus carica caprificus* L.) genotypes with random amplified polymorphic DNA (RAPD) markers. *Afr J Biotechnol* 10:519-526
- [15] Oukabli A., Mamouni A., Laghezali M., Ater M., Khadari B., Roger J.P., Kjellberg F. (2003). Genetical variability in Moroccan fig (*Ficus carica* L.) based on morphological and pomological data. *Acta Hort*. 605:311-318.
- [16] Khadari B., Oukabli A., Ater M., Mamouni A., Roger J.P., Kjellberg F. (2004). Molecular characterization of Moroccan fig germplasm using Intersimple Sequence Repeat and Simple Sequence Repeat markers to establish a reference collection. *HortScience* 40:29-32.
- [17] Vignaux L. (1988). Mise en place d'une clé de détermination ampélogométrique. Mémoire de D.A.A., ENSA, Montpellier, 55 p.

- [18] Schneider A and Zeppa G, 1988. Biometria in ampelografia: l'uso di una tavoletta frafica per effettuare rapidamente misure fillometriche. *Vignevisi*, 9, 37-40.
- [19] Romani L, Legido J.L SAA P and Cid N, (1992). Diseno y peusta a punto de un sistema informatico para la caracterizacion ampelometrica de variedades de vid. XX Congreso Mundial de la Vina y el Vino, 1992. Madrid (Espagne).
- [20] Alleweldt G. and Dettweiler E, (1986). Ampelograph studies to characterize grape-vine varieties. *Vignevisi*, 13, n° 12, 56-69.
- [21] Truel P and Boursiquot J.M, (1986). Etudes sur le matériel introduit dans les collections ampélographiques en vue de son identification et de la recherche des synonymes. *Vignevisi*, 13, n°12, 81-85.
- [22] Dettweiler E, (1987). Ein modell zur unterscheidbarkeit von rebsorten mit hilfe blattmorphologischer merkmale. Thèse Doctorale. Stuttgart-Hohenheim, 127p.
- [23] Costacurta A and Franceshet P.F, (1987). Individuazione e caratterizzazione di bio-tipi nell'ambito di cultivars di Vitis vinifera L. *Riv. Vitic. Enol.*, 7, 284-295.
- [24] Costacurta A and Zambon F, (1986). Il computer per la ricerca ampelografica. *Riv.Vitic. Enol.*, 11, 473-475.
- [25] Calo A, Costacurta A Cersoniso A Guist M, Marchetti S and Serafin L, (1986). Studio sull'applicazione del codice internazionale per la descrizione strandardizzata delle varietà di viti. *Vignevisi*, 13, n° 12, 69-72.
- [26] Calo A., Costacurta A, Giust M, Ottaviano E, Camussi A and Loernzoni C, (1989). Contributo preliminare alla individuazione di carrateri ampleografici ed ampelometrici atti alla carateerizzazione dei vitigni. *Riv. Vitic. Enol.*, 1,71-76.
- [27] Boursiquot L.M Faber M.P Blachier O and Truel P, (1987). Utilisation par l'informatique et traitement statistique d'un fichier ampélographique. *Agronomie*, 7, n°1, 13-20.
- [28] Diaz G, Setzu M, Diana A, Loi C, De martis B, Pala M and Bosselli M, (1991). Analyse de Fourier de la forme de la feuille de vigne. Première application ampéométrique sur un échantillon de 34 cépage implantés en Sardaigne. *J. Inter.Sci. Vigne et Vin*, 25, n°1, 37-39.