IMPORTANT MEDICINAL PLANTS - MOROCCO

Ajebli Mohammed and **Mohamed Eddouks**
Team of Ethnopharmacology and Pharmacognosy, Faculty of Sciences and Techniques Errachidia, Moulay Ismail University of Meknes, BP 509, Boutalamine, 52000. Errachidia. Morocco.

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Contents

Summary

For many thousands of years, medicinal and aromatic plants have been used in various cultures and old civilizations. This category of the plant kingdom plays an important role in human history, culture, and tradition. Morocco is one of the North African and Mediterranean countries. Its great geographical diversity accompanied by climate variability and the richness associated to both medicinal flora and traditional medicine and folklore, confers to Morocco a fabulous place in terms of medicinal and aromatic plants. In the present chapter, the most popular Moroccan Medicinal and Aromatic Plants (MAPs) were cited and treated according to their traditional and medicinal uses. Several species are endemic to Morocco, including Argan (*Argania spinosa*), atlas cedar (*Cedrus atlantica*), Moroccan Thyme (*Thymus atlanticus*), Moroccan Lavender (*Lavandula maroccana*); etc. This fabulous natural patrimony is supported by a strong know-how, which was translated by the development of an important Moroccan pharmacopeia. Many of these plants are edible and exploited for their artisanal, perfumery and cosmetics values. The majority of medicinal and aromatic plants known in Moroccan traditional medicine were scientifically studied for their biological

proprieties and pharmacological efficacy. In fact, bioactive compounds in plants, such as polyphenols, alkaloids; terpenes; peptides, sterols, etc. may be useful in the prevention of diseases. The toxic aspect is also among points of interest for pharmacologists; so, these species were investigated in this way.

This richness in terms of aromatic and medicinal plants must be matched by more effort in the purpose to best valorize and conserve these patrimonial natural resources.

In the present chapter, the objective is to make an inventory and to treat Moroccan medicinal and aromatic plants, the most known to be used to manage illnesses and to be utilized as foods or flavors in Morocco.

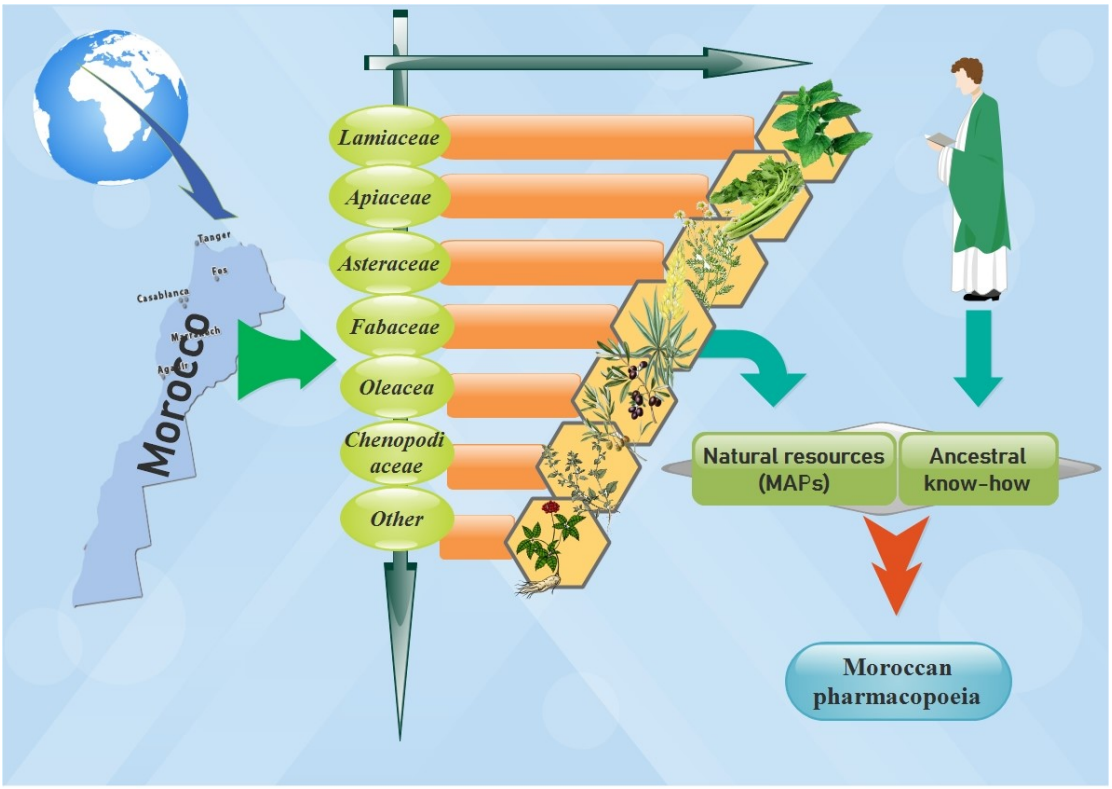

Figure 1. Graphical abstract illustrating the role of medicinal and aromatic plants to build a Moroccan pharmacopeia.

1. Introduction

Since the dawn of time, humans have used plants to cure themselves. Even if the current pharmacopoeia obscures them, many are those who are seduced by their medicinal abilities. Thus, in recent decades, the medicinal plant has made a comeback, based on sound values, tested for a long time by our ancestors. The transmission of know-how, by our elders, stopped with modern medicine. Thus, medicinal plants (MP) constitute a treasure of information for those who have decided to approach their daily ailments differently, by turning their backs on the chemical arsenal of current medicine. In fact, communities maintained oral traditions, and in time some developed the ability to document their experiences with medicinal plants in art and writing. Archaeological

evidence places the use of medicinal plants to as early as 5700 B.C.E. in Europe and approximately 4100 to 3500 B.C.E. in Asia (Merlin, 2003). In addition, all old civilizations (Chinese, Greek, Indian, Roman, Muslim) resorted to medicinal plants for their medicinal, aromatic properties as well as ritual uses (Yonos, 1997).

There are approximately 500,000 species of plants on earth, of which 80,000 have medicinal properties (Quyou, 2003). The African continent has a unique diversity of geographic and climatic factors. It has a similarly exceptionally rich and varied flora with an estimated 68,000 plant species, of which about 35,000 are known to be endemic (Cunningham, 1993). In this context, medicinal plants are valuable resources for the vast majority of rural populations in Africa, where more than 80% of this population use them for health care (Jiofack et al., 2009). Similarly, healing plants remain the only way of treatment for 70% of the world population. Based on its important geographical location and its diverse climate, Morocco is considered to be one of the richest Mediterranean countries in terms of flora, particularly aromatic and medicinal plants. Morocco is a Mediterranean country which is crossed from east to west and from south-west to north-east by four mountain ranges, the Rif, the Middle Atlas, the High Atlas and the Anti-Atlas. The Mediterranean Sea in the north, the Atlantic ocean in the west and the desert in the south, have a strong climatic influence which divides the country into many bioclimatic strata (El-Hilaly et al., 2003). In fact, among the 4.200 species and subspecies of Moroccan vascular plants, 800 species, subspecies and varieties are endemic (Bellakhdar, 1997). In addition, North Africa has nearly 1,700 endemic species and subspecies of which more than half are special to Morocco.

Morocco is one of the Mediterranean countries with a long medical tradition and traditional know-how based on medicinal plants (Scherrer et al., 2005). Indeed, traditional medicine has always occupied an important place in the traditions of medication in Morocco. However, the intensive exploitation of plant species for medicinal purposes can become harmful if it exceeds the threshold of sustainable regeneration by the resources used. In addition, the Moroccan medicinal flora remains unknown to this day, because of the few thousand plant species, the medicinal species counted do not exceed 356 species (Hmamouchi and Agoumi, 1993) and 600 species (Rejdali, 1996), i.e. 8.69% and 14.28% of the total Moroccan flora. The flora of Morocco has more than 7000 species and subspecies among which approximately 800 are aromatic and medicinal plants (Benabid, 2000).

Generally, when confronted with an ailment, indigenous people have always turned to the plants of their environment for their cures and gathered wild plants as medicine. Whereas your own medicine may come from the local drugstore, many of the medicines you are prescribed still contain drugs from a natural plant source. Native cultures had no such store to visit when they were sick. Instead, they depended on the healing plants of the fields, woodlands, marshes, deserts, and seashores they lived on (Young Kim, 2007). Interestingly, empirical knowledge of traditional herbal medicine has been transmitted verbally through the generations, and has been enriched thanks to a strategic geographical location between North Africa, the Sahara and the Sahel. This enrichment is also linked to the intermingling of Amazigh (Berber), Jewish, Saharan and Arab-Muslim civilizations (Bellakhdar, 1992). Currently, this medication, by plants, is experiencing a significant resurgence of interest, and it is, thanks to scientific studies

based on analytical methods and new experiments that the medical world is increasingly discovering the validity of prescriptions of empirical medicinal plants (Lahsissene et al., 2009). Interestingly, more than 25000 plants are used in the pharmacopoeia and more than 50 % of pharmaceutical products available on the market are of natural origin (Hamilton, 2003).

It is well known that plants and herbals serve as research tools as well. The compounds in some plants have enabled researchers to better understand how cancer cells grow. Other compounds have served as testing agents for potentially harmful food and drug products. Plants may offer a solution to a safer contraceptive (Young Kim, 2007). Approximately 4,000 plant species have already been shown to offer contraceptive capabilities (Tschanz, 2005). The forest may also provide a safer pesticide for farmers. Some wild potatoes have leaves that produce a sticky substance that traps and kills predatory insects. This natural self-defense mechanism could potentially reduce the need for using pesticides on potatoes, preventing some dangerous toxins from entering the environment. Obviously, it is estimated that one out of every four prescription drugs was discovered by ethnobotanical studies of medicinal plant uses by indigenous people (Mahato and Chaudhary, 2005).

2. Geographic Location and Climate of Morocco

Morocco is located at the northwest corner of the African continent, bordering the North Atlantic Ocean and the Mediterranean Sea (Ellicott, 2003). Morocco has two climatic zones: coastal and interior. Temperature variations are relatively small along the Atlantic coast, while the interior is characterized by extreme variations. The north and central areas have a Mediterranean climate, moderate and subtropical, cooled by the Mediterranean Sea and Atlantic Ocean. These areas characteristically have warm, wet winters and hot, dry summers. The average temperature hovers around 20°C (68°F). In the northern part of the interior, the climate is predominantly semiarid. Winters can be quite cold, and summers can be very hot. In the mountain ranges temperatures can drop as low as -18°C (0°F). Mountain peaks in both the Atlas and Er'rif mountain ranges are snow-capped throughout most of the year (Ellicott, 2003).

It is useful to mention that the sustainable management of natural resources at the level of this biosphere reserve therefore remains one of the priorities of our action. Because, the management measures to be practiced at the level of this reserve, which enjoys a special status and international support set up by UNESCO through the Man and the Biosphere Program (MBP), must be part of a logic of the conservation of natural resources and their use in a sustainable way by local populations (Anonymous).

3. Moroccan Endemic Flora

The vascular flora of Morocco counts 155 families distributed among the higher groups as follows: Pteridophyta, 17; Pinophyta, 4; Monocotyledonae, 36 and Dicotyledonae, 98. While, the number of genera rises to 981 indigenous to which must be added 24 of doubtful presence, 13 ± 2 weeds, 22 ± 2 naturalized and 19 under uncertain status (weed or naturalized?). The native genera are 25 Pteridophyta, 8 Pinophyta, 225 Monocotyledonae and 723 Dicotyledonae (Fennane and Tattou, 2008).

North Africa has nearly 1,700 endemic species and subspecies (which do not exist anywhere else), more than half of which are special to Morocco. This richness in endemics is due to the presence of specially contrasted and well differentiated environments, favorable to the creation of endemic species in Morocco. A colossal work has been undertaken recently to carry out an inventory of these species and to record the result (Anonymous, 2013).

In botany, a "herbarium" is a collection of plants dried and pressed between sheets of paper which serves as a physical support for various studies on plants, and mainly for taxonomy and systematics. The term herbarium also designates the establishment or institution which ensures the conservation of such a collection. Built up over time, the many herbaria, public and private, existing in the world constitute essential material for classification and botanical studies. At the scale of the countries of North Africa, the national herbarium (RAB) of the Scientific Institute (Mohammed 5-Agdal University, Rabat) is distinguished by its richness (more than 140,000 specimens) and by its continuity of its operation and services since its creation in 1920 (Anonymous, 2013).

Recently, thanks to local will and national and foreign support, it has been able to quickly integrate the current global trend of digitization of herbaria. Initially, financial assistance from the Mellon Foundation accompanied by assistance from Tela-Botanica made it possible to treat more than 1,500 taxa (species, subspecies and varieties) endemic and/or rare: digitization of exsiccata (Desiccated specimen plant stored in a herbarium) and inputting the content of the files into a database; all these data are now free to access (or will be very soon) on the websites of the Scientific Institute (www.israbat.ac.ma), of the Andrew Mellon Foundation in collaboration with Aluka (www.aluka.org) and Jstor (www.jstor.org) and the Musée National d'Histoire Naturelle de Paris (www.mnhn.fr) (Anonymous).

The authors therefore used bibliographic information and herbarium databases to draw up two important inventories concerning the vascular flora of North Africa (Mauritania, Morocco, Algeria, Tunisia, Libya and Egypt). The analysis of these inventories reveals a great floristic originality of this region of the world which is home to nearly 1,700 endemic species and subspecies, more than half of which are special to Morocco (Anonymous).

The lists that have been established are the result of a long process of searching for information and so will henceforth be a precious reference for all those who will be interested in these species for scientific studies, exploitation, protection or conservation.

4. Socio-economic Interest of MP in Morocco

Morocco has a good reputation in the field of aromatic and medicinal plants and it is a country with the strongest endemism among the countries of the southern Mediterranean. However, despite this richness and diversity, only 150 to 200 species and varieties are exploited in Morocco as medicinal and aromatic plants. The development of the sector comes up against several constraints such as the excessive exploitation of spontaneous MAPs and the limited recourse by farmers and producers to modern techniques of production, harvesting, processing and marketing of products.

According to a report published by the High Commission for Waters, Forests and Combating Desertification (HCWFCD), Morocco, the medicinal and aromatic plant (MAP) sector plays a very important socio-economic role, with annual revenues generated from MAP export of about 550 million Moroccan dirhams (about US$ 55.9 million) (Anoymous, 2012). In Morocco, sale of aromatic MP is a very lucrative business as a result of which 14,468 tons of essential oils and various plant material worth Dh 300,000 is exported annually (Kouhila et al., 2002). The highly utilized plants are Rosmarinus officinalis, from which 60 tons of essential oil are extracted and exported, Thyme and Lavender species, Artemisia herba-alba, Mentha pulgemium, Origanum compactum and Coriander sativum (Montanari, 2004). The Moroccan MAP sector provides employment to local and rural communities generating an estimated 500,000 work days per year. The main export markets for Moroccan MAPs are France and the United States of America but exported quantities are increasing due to opening of other markets including Japan, Canada, Switzerland, Spain, and Germany (Anonymous, 2016b).

Currently, Morocco is ranked 12th world exporter of MAPs. The main destinations for Moroccan exports of aromatic and medicinal plants are the European market. But, opening up to other destinations such as Japan, Canada, Switzerland, Spain and/or Germany, etc. has allowed volumes to increase. More than 50% of these exports concern the food sector (carob tree, spices, aromas, etc.), while 35% are intended for perfumery and cosmetics, while 5% are exploited for their medicinal properties. Since 2005, Moroccan exports from MAPs have experienced a significant increase. Thus, the value of MAPs exports increased from 67 MDH in 2002, to 233 MDH in 2014 (Anonymous, 2016a).

Some of Morocco's more important MAP products are: Argan kernel (*Argania spinosa*) fatty oil, atlas cedar wood (*Cedrus atlantica*) essential oil, bitter orange (Neroli) flower (*Citrus aurantium spp. aurantium*) flower and essential oil, carob fruit (*Ceratonia siliqua*), chaste tree fruit (*Vitex agnus-castus*) and extracts, clary sage herb (*Salvia sclarea*) and essential oil, damask rose flower bud (*Rosa damascena*) and absolute, khella fruit (*Ammi visnaga*) and essential oil, lavender flower (*Lavandula* spp.) and essential oil, mastic resin (*Pistacia lentiscus*) essential oil, Moroccan wild chamomile aerial parts (*Cladanthus mixtus*) and essential oil, Moroccan wild oregano herb (*Origanum compactum*) and essential oil, Moroccan wild thyme herb (*Thymus satureioides*) and essential oil, olive leaf (*Olea europaea*), orris root (*Iris germanica*) and essential oil, pennyroyal flowering herb (*Mentha pulegium*) essential oil, peppermint leaf (*Mentha piperita*) and essential oil, pomegranate fruit (*Punica granatum*) extract, rosemary leaf (*Rosmarinus officinalis*), essential oil, and extract, saffron style and stigma (*Crocus sativus*), Spanish pellitory root (*Anacyclus pyrethrum*), thyme herb (*Thymus vulgaris*) and essential oil, white wormwood herb (*Artemisia herba-alba*) and essential oil.

5. Moroccan Pharmacopeia and Traditional Medicine

Traditional Moroccan pharmacopoeia has been also considered as a rich source of medicinal plants, due to the diversity of the country in climates and biotopes. Morocco

also has a long history of folk medicine and a lot of plants are used by the local population especially in rural areas for the primary health care (Ait-Sidi-Brahim et al., 2019; Ajebli and Eddouks, 2019). In Morocco, the present medical tradition belongs to three main medical models. The first is figured as classical Arab medicine, based mainly on the humoral theories. The second is presented as a local popular medicine which constitutes a standard know-how throughout the country and the third can be considered as magico-religious practices, based on indigenous beliefs on spiritual causes of disease (Bellakhdar et al., 1991).

6. Important Moroccan Medicinal and Aromatic Plants

Morocco is one of the Mediterranean countries which has a long medicinal tradition and a traditional know-how based on aromatic and medicinal plants (Scherrer et al., 2005). It presents a fairly significant floristic richness thanks to variations in climatic and ecological conditions. Among the 4500 existing plant species, more than 280 plants are currently valued (Hmamouchi, 1997).

In terms of export volume, in the late 1990s the country was the second largest exporter of medicinal plants material from Africa and the ninth at international level (Lange and Mladenova, 1997). The country predominantly exports aromatic plants and essential oils. In 1994, about 508,200 tons of aromatic plants and essential oils worth about US$ 168.91 mn (1.7 bn Moroccan Dirhams) were exported (Hmamouchi, 1997). The aromatic plant and essential oil sector account for a major share of the economy of the country and have great potential to earn more foreign revenue. In the period between 1992 and 1995, Morocco exported 6,850 tons of medicinal plants worth US$ 12.85M to the international market (Vasisht and Kumar, 2004). Several products (more than 70) are exported in the form of dried plants for the food herbs trade. More than twenty species are used for the production of essential oils or other aromatic extracts intended primarily for the perfumery and cosmetic industry and also for the preparation of hygienic products and flavor formulations (Zrira, 2012). Interestingly, the harvesting of wild growing species represents more than 90% of national production. The number of wild-crafted species is large. Their most important representatives are rosemary, thyme, pennyroyal, artemisia, oregano, myrtle and carob seeds (Neffati et al., 2017). The most important cultivated species are verbena, coriander, sage, mint, lavender, geranium, bergamot, citrus, basil and saffron (Zrira, 2012).In this review, a brief description of some important species in Morocco is given such as: *Argania spinosa, Thymus species, Artemisia herba-alba, Cedrus atlantica, Laurus nobilis, Rosa damascena, Nerium oleander L, Capparis spinosa L, Urtica dioïca L, and Rosmarinus offiinalis* (Tables 1.1-1.9). The harvesting of wild growing species represents more than 90% of national production. The number of wild-crafted species is large. Their most important representatives are rosemary, thyme, pennyroyal, Artemisia, oregano, myrtle and carob seeds (Zrira, 2017).

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Biographical Sketches

Mohammed Ajebli was born in 1983 in the province of Taza (Morocco). He obtained his High School degree in experimental sciences in 2002 from Ibn Alkhateb high school in the city of El Hajeb. He graduated with a Basic Bachelor in Biology from the Faculty of Sciences of Meknes (Moulay Ismail University) in 2007; he obtained a professional Bachelor in physico-chemical and environmental analysis from the same university in 2011; then, he graduated with the Master specializing degree in biotechnology and valuation of aromatic and medicinal plants from the same faculty. Finally, he obtained a national doctorate degree in biology (specialty: pharmacology and human physiology) in 2021 from the Faculty of Sciences and Techniques of Errachidia (Moulay Ismail University), and this under the supervision of Professor Mr Mohamed Eddouks (Teacher and researcher at Moulay Ismail University). He has contributed to the production of several publications in the field of pharmacology and medicinal plants within the Ethnopharmacology and Pharmacognosy laboratory.

Mohamed Eddouks is Professor at Moulay Ismail University of Meknes, Faculty of Sciences and Techniques Errachidia, Morocco. He is a researcher in Physiology and Pharmacology with a Master Degree in Metabolic and Molecular Endocrinology from University of Paris 6, a specialized certificate in Endocrine Pharmacology from University of Paris 7 and PhD degree in Physiology and Pharmacology from University of Liege, Belgium and PhD degree from Sidi Mohammed Ben Abdellah University, Fez, Morocco. After his post-doctoral fellowship at Department of Physiology, Faculty of Medicine of Montreal, Canada, he is working for the last 20 years on medicinal plants. His research focuses on ethnobiological as well as pharmacological issues in the use of Moroccan medicinal plants for the treatment of diabetes mellitus, hypertension and obesity. His contribution to this field includes 5 international books, 6 special issues and more than 138 indexed peer-reviewed articles and 21 book chapters of international repute with over 3600 citations and h index (Scopus=31). He is Regional Editor

of two International Journals and member of Editorial Board of over 20 international journals. He has been awarded the first Prize of the Federation of Arab Scientific Councils in 2016 and the first Prize of Scientific Research of the Moroccan Association of Research and Development in 2008. He has been classified by the Moroccan National Center of Scientific Research and Technology among the top 3 researchers in the field of Pharmacology based on the scientific publications between 2000 and 2014. He has been the founding Dean of Polydisciplinary Faculty of Errachidia, Morocco from 2008 to 2012 and Vice Dean of Scientific Research and Cooperation at Faculty of Sciences and Techniques Errachidia (2005-2008).