

Aromatic and Medicinal Plants in Morocco: Diversity and Socio-Economic Role

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Abstract— Morocco is characterized by a great richness and diversity in aromatic and medicinal plants and it has an ancestral knowledge in the use of plants for medicinal and cosmetic purposes. In effect, the poverty of riparian, specially, mountain populations have greatly contributed to the development of traditional pharmacopoeia in Morocco. The analysis of the bibliographic data showed that a large number of plants in Morocco are exploited for aromatic and medicinal purposes and several of them are commercialized internationally. However, these potentialities of aromatic and medicinal plants are currently subjected to climate change and strong human pressures: Collecting fruits, agriculture development, harvesting plants, urbanization, overgrazing...

Keywords—Aromatic, medicinal, plants, socioeconomy, Morocco.

I. INTRODUCTION

THE use of aromatic and medicinal plants in recent decades has generated a lot of pressure on these resources, and several species suffer from excessive harvest without taking into account the existing potential. Of these, we can mention: *Origanum elongatum* Emb. & Maire, *Thymus satureioides* Cosson, *Thymus vulgaris* L., *Laurus nobilis* L., *Anacyclus pyrethrum* (L.) Link, *Ormenis mixta* (L.) Dumort. Other species such as *Rosmarinus officinalis* L., *Artemisia herba-alba* Asso which currently have large areas but under the influence of intensive sampling could be threatened in the future.

On the socio-economic level, the exploitation of aromatic and medicinal plants constitutes important revenue for local populations.

II. METHODOLOGY

The methodology is mainly based on a literature review of principal theses and projects for the flora, vegetation and aromatic and medicinal plants.

III. RESULTS

A. Inventory

Among 5211 species and subspecies of vascular plants inventoried in Morocco [1], 800 vascular plants have medicinal and aromatic value.

The compilation of several scientific researches [2]-[4] was used to establish a list of the main aromatic and medicinal plants (Table I).

B. Use and Socio-Economic Value

Aromatic and medicinal plants contain essential oils that are used in the cosmetic industry, perfumery where they are considered as basic elements, as well as in the field of aromatherapy.

The market for essential oils and other products taken from these plants has experienced, in Morocco, an increase in quantity for sale on the market. In addition to essential oils, this activity provides about a hundred tons of dry grass. Currently, the activities of transformation and recovery of aromatic and medicinal plants allow export of nearly 1,000 tons of essential oils and various extracts and about 400 tons of dried herbs for a total value of approximately 300 million MAD [5].

Socio-economically, harvesting of medicinal and aromatic plants is a way to diversify agricultural production and still generating activities for local people. This activity provides the local population about 500 000 working days for an income of 25 million MAD and generates extra revenue for rural communities. Only, the use of *Rosmarinus officinalis* provides approximately 81.000 day work/year which correspond to a value of 4.050.000.00 MAD [5]. On the global level, Morocco produces:

- 1 000 tons of essential oils: 150 million MAD
- Approximately 80 tonnes of medicinal plants: 100 million MAD and generates about 500,000 Men day work [6].

Production is generally carried out by spontaneous medicinal and aromatic plants, while crops contribute about 2%.



Fig. 1 Extraction of *Rosmarinus officinalis* essential oil

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TABLE I
MAIN AROMATIC AND MEDICINAL PLANTS [4]

Species	Families	Status of species
<i>Pistacia atlantica</i> Desf. <i>Pistacia lentiscus</i> L. <i>Rhus pentaphylla</i> (Jacq.) Desf. <i>Rhus tripartita</i> (Ucria) Moffett	Anacardiaceae	
<i>Ammi visnaga</i> (L.) Lam. <i>Bupleurum spinosum</i> Gouan <i>Ferula communis</i> L. <i>Foeniculum vulgare</i> Miller <i>Pimpinella tragiun</i> Vill. <i>Thapsia transtagana</i> Brot.	Apiaceae	
<i>Nerium oleander</i> L.	Apocynaceae	
<i>Ilex aquifolium</i> L.	Aquifoliaceae	
<i>Arisarum vulgare</i> Targ.-Tozz.	Araceae	
<i>Chamaerops humilis</i> L.	Arecaceae	
<i>Aristolochia paucinervis</i> Pomel	Aristolochiaceae	
<i>Calotropis procera</i> Aiton <i>Caralluma europaea</i> (Guss.) N. E. Br. <i>Pergularia tomentosa</i> L. <i>Periploca angustifolia</i> Labill.	Asclepiadaceae	
<i>Asparagus albus</i> L. <i>Asparagus stipularis</i> Forsk.	Asparagaceae	
<i>Asphodelus fistulosus</i> L. <i>Asphodelus ramosus</i> L. <i>Asphodelus tenuifolius</i> Cav.	Asphodelaceae	
<i>Artemisia herba alba</i> Asso. <i>Achillea santolinoides</i> Lag. <i>Anacyclus pyrethrum</i> (L.) Link <i>Anvillea radiata</i> Coss. & Dur. <i>Artemisia flahaultii</i> Emb. & Maire <i>Artemisia ifranensis</i> J. Didier <i>Artemisia mesatlantica</i> Maire <i>Artemisia negrei</i> Ouyahya <i>Brocchia cinerea</i> (Del.) Vis. <i>Calendula arvensis</i> L. <i>Centaurea maroccana</i> Ball. <i>Centaurea pungens</i> Pomel <i>Echinops spinosus</i> L. <i>Inula viscosa</i> Ait. <i>Kleinia antephorbium</i> (L.) Haw. <i>Launaea arborescens</i> (Batt.) Murb. <i>Ormenis mixta</i> (L.) Dumt. <i>Scolymus hispanicus</i> L. <i>Warionia saharae</i> Benth. & Coss.	Asteraceae	RRE RRE E E E E
<i>Berberis hispanica</i> Boiss. & Reut. <i>Echium plantagineum</i> L.		
<i>Anastatica hierochuntica</i> L. <i>Farsetia aegyptiaca</i> Turra <i>Farsetia hamiltonii</i> Royle <i>Matthiola maroccana</i> Coss. <i>Morettia canescens</i> Boiss. <i>Moricandia arvensis</i> (L.) D.C.	Brassicaceae	
<i>Buxus balearica</i> Lam.	Buxaceae	
<i>Capparis decidua</i> (Forsk.) Edagew <i>Capparis spinosa</i> L. <i>Cleome Arabica</i> L. <i>Maerua crassifolia</i> Forsk.	Caparaceae	
<i>Herniaria hirsute</i> L. <i>Paronichia arabica</i> (L.) D C. <i>Paronichia argentea</i> Lam.	Caryophyllaceae	
<i>Atriplex halimus</i> L. <i>Chenopodium ambrosioides</i> L. <i>Fredolia aretioides</i> (Bunge) Ulbr. in Engler & Prantl <i>Hammada scoparia</i> (Pomel) Il'in	Chenopodiaceae	
<i>Cistus albidus</i> L. <i>Cistu sclusii</i> Dunal <i>Cistus crispus</i> L.		

Species	Families	Status of species
<i>Cistus ladanifer</i> L. <i>Cistus monspeliensis</i> L. <i>Cistus populifolius</i> L. <i>Cistus salviifolius</i> L. <i>Helianthemum croceum</i> (Desf.) Pers. <i>Helianthemum lippii</i> (L.) Pers.	Cistaceae	R ?
<i>Convolvulus althaeoides</i> L. <i>Convolvulus trabutianus</i> Schweinf. & Muschler	Convolvulaceae	
<i>Coriaria myrtifolia</i> L.	Coriariaceae	
<i>Cupressus atlantica</i> Gaussen <i>Juniperus communis</i> L. <i>Juniperus oxycedrus</i> L. <i>Juniperus phoenicea</i> L. <i>Juniperus thurifera</i> L. <i>Tetraclinis articulata</i> Masters	Cupressaceae	VE RR V
<i>Dracaena draco</i> (L.) L.) subsp. <i>ajgal</i> Benabid et Cuzin	Dracaenaceae	
<i>Ephedra fragilis</i> Desf.) <i>Ephedra major</i> Host.	Ephedraceae	
<i>Arbutus unedo</i> L. <i>Erica arborea</i> L. <i>Erica multiflora</i> L. <i>Erica scoparia</i> L.	Ericaceae	
<i>Euphorbia echinus</i> Coss. & Hook. <i>Euphorbia nicaensis</i> All. <i>Euphorbia resinifera</i> Berg. In Berg. & Schmidt	Euphorbiaceae	E
<i>Ceratonia siliqua</i> L. <i>Acacia raddiana</i> Savi <i>Crotalaria saharae</i> Coss. <i>Teline lignifolia</i> (L.) Webb & Berth. <i>Astragalus armatus</i> Willd. <i>Argyrocystis battandieri</i> (Maire) C. Raynaud <i>Acacia gummifera</i> Willd. <i>Anagyris foetida</i> L. <i>Ononis natrix</i> L. <i>Retama retam</i> (Forsk.) Webb. <i>Retama monosperma</i> Boiss. <i>Retama sphaerocarpa</i> (L.) Boiss.	Fabaceae	E E
<i>Quercus coccifera</i> L. <i>Quercus rotundifolia</i> (Lam.) T. Morais <i>Quercus faginea</i> Lamk. <i>Quercus suber</i> L.	Fagaceae	
<i>Globularia alypum</i> L. <i>Globularia nainii</i> Batt.	Globulariaceae	RE
<i>Drimis maritima</i> (L.) Stearn <i>Juncus maritimus</i> L.	Hyacinthaceae Juncaceae	
<i>Ballota hirsuta</i> Benth <i>Rosmarinus officinalis</i> L. <i>Lavandula dentata</i> L. <i>Lavandula maroccana</i> Murb. <i>Lavandula multifida</i> L. <i>Lavandula stoechas</i> L. <i>Marrubium ayardii</i> Maire <i>Marrubium multibracteatum</i> Humbert & Maire <i>Marrubium vulgare</i> L. <i>Mentha longifolia</i> (L.) Hudson <i>Mentha pulegium</i> L. <i>Mentha rotundifolia</i> L. <i>Nepeta amythystina</i> Poir in Lam. <i>Origanum compactum</i> Benth. <i>Origanum elongatum</i> (Bonnet) Emb. & Maire	Lamiaceae	E E E E E VE

Species	Families	Status of species
<i>Salvia aegyptiaca</i> L.		
<i>Salvia aucheri</i> Benth		
<i>Salvia officinalis</i> L.		
<i>Salvia verbenaca</i> (L.) Briq.		
<i>Satureja alpina</i> (L.) Scheele		
<i>Satureja calamintha</i> (L.) Scheele		RR
<i>Teucrium chamaedrys</i> L.		
<i>Teucrium fruticans</i> L.		
<i>Teucrium mideltense</i> (Batt.) Humbert		E
<i>Teucrium polium</i> L.		
<i>Ziziphora hispanica</i> L.		
<i>Thymus ciliates</i> Desf.		
<i>Thymus satureioides</i> Coss.		
<i>Thymus atlanticus</i> (Ball) Roussine		E
<i>Thymus broussonetii</i> Boiss.		E
<i>Thymus maroccanus</i> Ball		E
<i>Thymus riatarum</i> Humbert & Maire		E
<i>Laurus nobilis</i> L.	<i>Lauraceae</i>	
<i>Malva sylvestris</i> L.	<i>Malvaceae</i>	
<i>Myrtus communis</i> L.	<i>Myrtaceae</i>	
<i>Nitraria retusa</i> (Forssk.) Asch.		
<i>Peganum harmala</i> L.	<i>Nitrariaceae</i>	
<i>Olea europaea</i> L.		
<i>Fraxinus dimorpha</i> Cosson & Durieu	<i>Oleaceae</i>	
<i>Jasminum fruticans</i> L.		
<i>Phillyrea angustifolia</i> L.		
<i>Phillyrealatifolia</i> L.		
<i>Fumaria officinalis</i> L.		
<i>Papaver rhoeas</i> L.	<i>Papaveraceae</i>	
<i>Abies maroccana</i> Trabut		
<i>Cedrus atlantica</i> Manetti	<i>Pinaceae</i>	RE
<i>Pinus halepensis</i> Mill.		
<i>Pinus pinaster</i> Aiton		
<i>Polygala balansae</i> Cosson	<i>Polygalaceae</i>	
<i>Delphinium staphisagria</i> L.		
<i>Nigella arvensis</i> L.	<i>Ranunculaceae</i>	R
<i>Nigella damascena</i> L.		
<i>Rhamnus lycioides</i> L.	<i>Rhamnaceae</i>	
<i>Ziziphus lotus</i> (L.) Lam.		
<i>Crataegus laciniata</i> Ucr.		
<i>Crataegus monogyna</i> J. acq.	<i>Rosaceae</i>	
<i>Rubus ulmifolius</i> Schott		
<i>Pyrus mamorensis</i> Trab.		E
<i>Ruta montana</i> L.	<i>Rutaceae</i>	
<i>Osyris alba</i> L.	<i>Santalaceae</i>	
<i>Argania spinosa</i> (L.) Skeels	<i>Sapotaceae</i>	E
<i>Digitalis purpurea</i> L.	<i>Scrophulariaceae</i>	V
<i>Verbascum sinuatum</i> L.		
<i>Lycium intricatum</i> Boiss.		
<i>Mandragora autumnalis</i> Bertol.	<i>Solanaceae</i>	
<i>Withania adpressa</i> Coss.		
<i>Withania frutescens</i> (L.) Pauquy		
<i>Taxus baccata</i> L.	<i>Taxaceae</i>	V
<i>Daphne gnidium</i> L.		
<i>Daphne laureola</i> L.		
<i>Thymelaea hirsuta</i> (L.) Endl.	<i>Thymelaeaceae</i>	
<i>Thymelaea tartanraira</i> (L.) All.		
<i>Vitex agnuscastus</i> L.	<i>Verbenaceae</i>	
<i>Balanites aegyptiaca</i> (L.) Del.		
<i>Zygophyllum gaetulum</i> Emb. & Maire	<i>Zygophyllaceae</i>	

R?: Suspected rare; E: Endemic; VE: Vulnerable and Endemic; RE: Rare and Endemic; RRE: Very rare and Endemic[6].

C. Production and Export of Medicinal and Aromatic Plants

Currently, Morocco is ranked the 12th exporter of aromatic and medicinal plants in the world [8] and has great potential in the field of medicinal and aromatic plants:

An area of about 1 million hectares *Rosmarinus officinalis* L. produces about 60 tons of essential oils. *Rosmarinus officinalis* is the second most exported herb by Morocco (19%). Export quantities and revenues of *Rosmarinus officinalis* have increased between 2001 and 2006, respectively 0.6 tons (equivalent 574 666 MAD) and 13 tons (equivalent to 12,305,333 MAD), which allows Morocco to occupy the 2nd place in the international market after Spain [4].



Fig. 2 *Rosmarinus officinalis* L.

The rosemary exploitation provides about 100,000 work days per year, which corresponds to a value of 4,050,000.00 MAD. Rosemary is the herb most exported by Morocco (12.70% of all dried aromatic and medicinal plants) [4].

The average exports from Morocco in essential oils of *Myrtus communis* L. are estimated at 1180 kg of essential oils for a value of 652,000 MAD [4].

Origanum compactum Benth & *Oiganum elongatum* (Bonnet) Emb. & Maire occupy an important place in the world level. The estimate of world production is about 10 000 tons. Morocco has exported 77 tons equivalent to 1,125,844 MAD [4].



Fig. 3 *Origanum elongatum* (Bonnet) Emb. & Maire

Artemisia herba alba Asso is also of great economic interest in Morocco. Its essential oil content ranges from 1 to

1.5% of dry matter. Its essence is for the industry of cosmetology and perfumery. The Morocco holds 90% of the global market [9].



Fig. 4 *Artemisia herba alba* Asso

The essential oil production potential of *Mentha pulegium* L. was estimated between 10 and 30 tons/year. The average exports were an average of 10 tons/year for a value of 2 million MAD [9].

Morocco also has significant potential in *Capparis spinosa* L.; capers are especially subject to substantial international trade (daily Echos No. 570, 2012). Indeed 95% of domestic production is exported to European and American markets [4].

Export of *Thymus* is as important as that of *Rosmarinus officinalis*. Indeed, the average tonnage of this material is exported 1,140 t/year with an average value of 12.9 million MAD. These exports represent in value 4% for heading dried aromatic and medicinal plants and locust beans [4].

According to Exchange Office, 2006 the value of exports of essential oils spontaneous aromatic and medicinal plants are growing. They rose from 56 million MAD in 2000 to 112,400,000 MAD in 2003 [4].

The data for the whole sector (essential oils, aromatic and medicinal plants, carob and derivatives) show that the average annual total revenues of exports over the period 1999 to 2003 are 615 million MAD for an average annual volume of 32,000 tons, an average unit selling price of 19.85 MAD for 1 Kg [4].

D. Access and Benefit Sharing (ABS)

Aromatic and medicinal plants are a fundamental element in the access and benefit sharing process. However, with the exception of *Argania spinosa*, for which there are certain benefits arising from the exploitation of its products (rehabilitation of degraded areas, development of living standards of local populations, women's cooperatives, etc.) and *Rosmarinus officinalis*, which is the subject of tender procedures, and whose local populations derive a small profit from its collection, the exploitation of the majority of the other aromatic and medicinal resources is not regulated and is done in an often anarchic way. Only a law regulating access and benefit sharing could remedy this problem [4].

IV. MAIN THREATS

In addition to grazing and drought, the use of resources and medicinal aromatic plants recent decades has generated a lot

of pressure on these resources, and several species suffer from excessive harvest without taking into account the existing potential. Among the most frequently used aromatic and medicinal plants, it is necessary to mention: *Origanum elongatum*, *Thymus* spp. (*Thymus satureioides*, *Thymus vulgaris* ...), *Laurus nobilis*, *Anacyclus pyrethrum*, *Ormenis mixta*, *Rosmarinus officinalis* and *Artemisia herba alba*.



Fig. 5 *Thymus satureioides* Coss

V. CONCLUSION

Morocco has a great geographical diversity (plains, low, medium and high mountains, valleys, cliffs etc.) accompanied by climate variability that led to the installation and development of rich and varied flora which aromatic and medicinal plants represents more than 15%.

Socio-economically, harvesting of medicinal and aromatic plants is a way to diversify agricultural production and still generating activities for local people. This activity provides the local population about 500 000 working days for an income of 25 million MAD and generates extra revenue for rural communities [4].

Sometimes exploiting these plants is done in a haphazard manner which has negative consequences on the resources of aromatic and medicinal plants.

The establishment of a sharing process provides a better develop these resources and traditional knowledge associated with them.

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