Initial Assessment of Medicinal Plants Across the Libyan Mediterranean Coast

Article *in* Advances in Environmental Biology · January 2011

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Advances in Environmental Biology, 5(2): 359-370, 2011
ISSN 1995-0756

ORIGINAL ARTICLE

Initial Assessment of Medicinal Plants Across the Libyan Mediterranean Coast

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ABSTRACT

The medicinal plants of the Libyan Mediterranean Coast represent an opportunity to reduce rural poverty in the arid and semi-arid ecosystems due to their water use efficiency, low costs of collection and cultivation, high economic returns per unit area, and the creation of new jobs within the value-added activities of processing and marketing. However, major medicinal plants in the region are in danger of extinction due to global climate change, overgrazing, uprooting, and wood cutting. Mitigating this depletion of biodiversity along the Libyan Coast requires: 1) *ex-situ* conservation of important plant genetic resources in the national genebank; 2) establishment of field genebanks in the two major agro-ecological zones; and 3) conservation of selected specimen in the national herbarium. During the spring and summer of 2009 and 2010 collection missions were conducted along the Libyan Mediterranean coast. The field visits occurred, and surveyed a total of 79 sites across the western and eastern coastal areas of Libya. The collection mission recorded a total of 151 species belonging to 47 families, the most dominant of which were Chenopodiaceae (20 %) followed by Fabaceae (13 %). 78 species with medicinal benefits were encountered, the most prevalent of which were the Lamiaceae (12 %) and Fabaceae (10 %) families. Major medicinal plants were classified according to their life form and various uses. Given the ecological, social, and economic benefits of medicinal plants in Libya, this sector must be developed through the following research strategy. First, a thorough inventory and mapping of all potential medicinal plants in Libya and their status should be established and regularly maintained. Second, decision-makers should develop clear policies for the protection/conservation, production, transportation, and marketing of medicinal plants. In particular, a national program based upon scientific standards should collect seeds and conserve key medicinal plants in the national genebank. Furthermore, improve public awareness of the importance of medicinal plants, and build on traditional knowledge and cultural heritage.

Key words: Libya, medicinal plants, multi-purposes species, biodiversity, genebank, herbarium, rangelands

Introduction

Worldwide, between 50,000 and 80,000 flowering plants are used in traditional medicine [15]. Growing global demand for herbal, medicinal, and aromatic plants has created a new niche market for these products valued at $60 billion US per year, with an average annual growth rate of about 7 % [13]. In recent years, such medicinal plants have also been recognized as a significant source of livelihood opportunities for the rural poor, especially women, the landless poor, and marginalized farmers, and also constitute an important source of revenue for governments. In fact, due to the over-exploitation of some wild species, a number of institutes recommend that wild species be brought under cultivation [28,29]. Furthermore, medicinal plants often provide a buffer in times of low

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employment, crop failure, and other periods of economic stress [8]. Finally, they represent a promising opportunity for reducing rural poverty and achieving economic development in dry ecosystems because of their higher water use efficiency, relatively higher economic return per unit area compared to traditional crops, and the potential to add value through processing and marketing [20,12].

Libya lies along the southern coast of the Mediterranean in North Africa and has a total area of about 1,759,540 km^2, of which more than 90 % is desert. The climate is typical Mediterranean, with erratic rainfall. Agriculture and arid and semi-arid rangelands are limited to a narrow strip along the Mediterranean coast. Nevertheless, Libya has a number of advantages in medicinal plants production, including low production costs, favorable climatic conditions, large areas of wild medicinal species, and proximity to European markets. Unfortunately, its medicinal plants have been degraded because of over-exploitation due to deforestation, cultivation, and overgrazing; the absence of adequate policies and legislation; and habitat degradation and loss attributable to climatic change and its associated intensification of drought [310,18], all of which will inevitably result in the impoverishment of a large number of people.

It is now recognized that many wild harvested medicinal plants face extinction or severe genetic loss, but detailed information on the extent of this degradation is either unavailable or poorly documented due to the limited amount of formal research undertaken on medicinal plants in Libya. Thus, much research is needed to ensure the safeguarding of highly threatened species, either within their natural habitats or in artificial settings, and to thereby protect these resources for future generations (Given, 1994). The overall objectives of this study were: 1) to assess the status of multi-purposes species, particularly medicinal plants, across the Libyan Mediterranean Coast; and 2) to present recommendations for the conservation, management, and sustainable utilization of medicinal plants in Libya.

Materials and methods

Details about the sites:

The surveyed areas experience arid, temperate winters with an average annual rainfall of 220 mm that varies from 150 mm to 300 mm. 79 sites were surveyed in the western and eastern coastal areas of Libya, covering a wide range of geographical areas and ecosystems (Figure 1). This heterogeneity consisted of seven morphological zones (namely, forest, valleys, rangelands, *sabkhas* [saline depressions], sand dunes, roads sides, and sea sides), each with unique flora and vegetation (Table 1). The respective zones provide environmental niches for hundreds of wild medicinal species used by indigenous communities for food and medicine.

Of the collected species, more than 70 were gathered from rangelands, mainly because of the huge area occupied by rangelands in Libya (Figure 2). In terms of species richness, valleys (*wadis*) were more diversified per unit area than any other geomorphologic zones. These ecosystems generally have higher fertility levels and better than average water availability.

Data collection:

Seed collection and vegetation survey of medicinal plants were conducted across seven morphological zones mentioned above. In addition to the site description, detailed ethno-botanical data and herbarium material were gathered to confirm uses and species identification. The following information was recorded during the collection missions:

Sample seed collection:

For each matured species, a small sample of seed was harvested. The collection date, collector's name, location, site number, coordinates (longitude, latitude), altitude, rainfall, habitat, aspect, slope, and soil data were recorded.

Plant characteristics:

Identification and nomenclature of plant species, including botanical name, local name, common name, and family name, were performed according to Keith [17], IPNI [14], and USDA-ARS[27]. Abundance of each species was determined quantitatively based on presence percentage according to the following scale: dominant (greater than 25 %); associated (less than 10 %); and rare (less than 5 %). Growth form (erect, semi-erect, or prostrate) and life form (trees, phanerophyte, chamaephyte, annual shrubs, perennial forbs, perennial grasses, biennial forbs, therophyte, or climbers) were assigned following Ali and Jari [1] and Sankary[26]. In addition, a close-up photograph was taken.

Herbarium sample collection: Specimens of medicinal plants collected in this study were deposited at the National Genebank in Tripoli, Libya. Percent vegetation and stone covers were measured at each site using visual estimation [21,23].

Economic uses:

The majority of the encountered wild species have a wide array of uses, including human food, feed for livestock and wildlife, fuel, medicine, and

Table 1: Characteristics of the surveyed sites in the Mediterranean coast of Libya

Geographic type	Site	East	Nourth	Altitude (m)	Aspect	Slope (%)	Percent Cover	
							Stones	Vegetation
Forest								
Degraded	Al Koof	21° 18' 47.02"	32° 34' 52.90"	302	S	5	10	30
	Jardas	21° 46' 53.00"	32° 31' 21.97"	691	W	8	60	10
Protected	Herdanem	20° 40' 46.84"	32° 35' 00.84"	32	N	5	25	40
	Al-Zarda	22° 05' 55.51"	32° 47' 33.71"	386	E	5	20	75
	Belghra	21° 40' 37.45"	32° 42' 18.79"	527	W	5	25	40
	Al-Arkoob Abyad	22° 09' 34.01"	32° 50' 03.06"	488	S	7	20	65
Artificial	Slenta	21° 22' 28.96"	32° 36' 03.20"	825	N	5	5	60
Valleys								
Jabal Al- Akhdar		Wadi Al-Koof	21° 34' 26.15"	32° 42' 43.12"		392	F	0
	30	60						
	Slook	20° 33' 02.45"	31° 33' 02.66"	70	E	5	2	10
	Sadd Al Qatara	20° 23' 59.24"	32° 01' 47.46"	209	S/E	30	50	40
	Darnah	22° 36' 38.34"	32° 42' 14.40"	101	F	0	5	75
Jabal Al- Gharbi		Hera	13° 01' 42.03"	32° 25' 58.51"		141	F	0
	15	30						
	Al-Ramel	13° 35' 31.81"	32° 46' 54.08"	122	F	0	0	10
Rangelands								
Protected	Abu Ghelann	13° 01' 42.93"	32° 15' 40.55"	258	W	8	20	60
	Ein Toube	13° 02' 09.04"	32° 10' 38.08"	606	E	3	10	70
	Reserve Shaafeen	13° 49' 58.01"	32° 36' 38.23"	383	W	6	15	40
	Reserve Al Toyoor	11° 32' 47.11"	32° 54' 38.99"	17	F	0	0	20
	Montazah Tala	10° 59' 16.58"	31° 52' 05.09"	491	N	28	15	45
Unprotected	The foot of Jabal Al Gharbi	13° 02' 47.77"	32° 20' 17.09"	204	F	0	20	40
	South Mezda	13° 04' 01.96"	31° 19' 29.82"	437	F	0	3	7
	Mizdah	13° 03' 00.46"	31° 24' 06.65"	443	F	0	50	2
	Sadadeh	14° 56' 15.47"	31° 35' 07.48"	19	F	0	55	3
	Om Rezam	22° 56' 23.03"	32° 33' 47.70"	133	Ft	0	35	5
	Mrassasa	23° 46' 14.66"	32° 05' 50.82"	91	F	0	5	10
Depressions	West Jardas	21° 46' 39.47"	32° 26' 30.80"	594	F	0	15	15
	Al-Herabeh	11° 30' 31.90"	31° 42' 22.93"	640	F	0	5	18
Sabkha								
	Hiesha Jadida	15° 13' 21.88"	31° 30' 12.47"	45	F	0	2	45
	Al Jbebeneh	11° 32' 47.11"	32° 54' 38.99"	17	F	0	0	20
	Al–Qaminis	19° 57' 16.08"	31° 42' 27.09"	12	F	0	3	45
Sand dunes								
	West slook	20° 21' 02.99"	31° 38' 20.80"	72	F	0	0	10
	Nafad	14° 44' 00.74"	31° 31' 49.84"	90	F	0	0	5
	Maghzar Sabbet	11° 49' 22.19"	32° 46' 00.70"	35	F	0	0	8
Road sides								
	Qarnada	21° 54' 24.62"	32° 43' 47.35"	645	F	0	10	20
	Al Athron	22° 05' 44.30"	32° 52' 19.75"	19	F	0	45	40
Sea sides								
	Sail Amer	21° 51' 43.99"	32° 54' 33.19"	3	F	0	10	10
	Tubroq	23° 57' 57.46"	32° 04' 37.27"	1	F	0	0	5

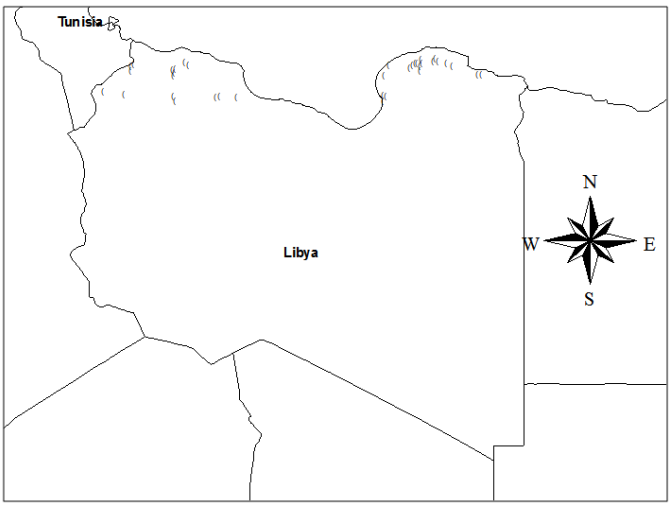

Fig. 1: A map showing the study area. Black dots represent visited sites along the Libyan Mediterranean coast

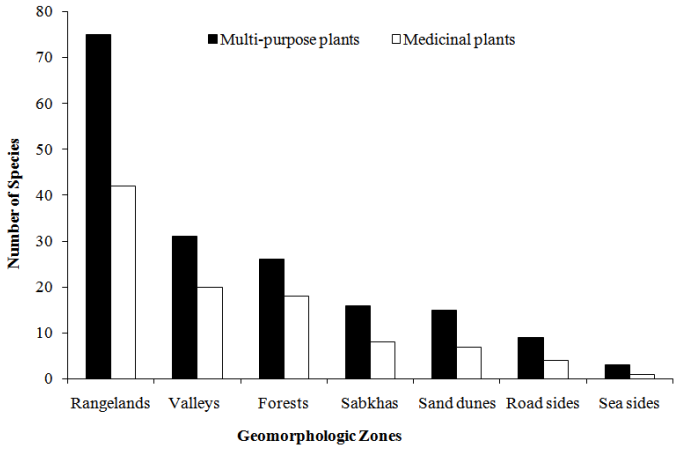

Fig. 2: Number of species per geographical zones recorded during the collection missions of the Mediterranean coast of Libya in the spring and summer of 2009 and 2010

environmental uses (such as erosion control and sand dune fixation)[6,30].

Medicinal use and part of medicinal plant used:

Indigenous people actively engage in traditional healthcare practices, and local experts were interviewed to record their unique knowledge about the medicinal values of different plant species. Information on the medicinal value of plants was counterchecked against the available literature[1,2,516,7,25].

Results and discussion

The assessment undertaken during the spring and summer of 2009 and 2010 recorded 151 plant species (132 perennials, 2 biennials, and 17 annuals) belonging to 117 genera and 47 families (Table 2). Among these species, 19 are endemic, 25 are rare (19 perennials and six annuals), 15 are noteworthy species, and 10 species are under threat. 90 species (or 59.6 %) are woody plants (mainly shrubs), with 55 phanerophytes, 11 chamaephytes, and 24 trees. 88 species (58.3 %) possess at least one aspect that has a potential or actual economic use, most commonly in grazing or medicine.

31 plant communities were identified across the seven geomorphological zones where rangeland sites have the highest number with 13 different assemblages of plant species (Table 3). From an ecological and vegetation viewpoint, then, the Libyan Mediterranean Coast has a rich biodiversity, and accounts for the majority of the species found in the Libyan Mediterranean region, the richest phyto-geographical region in Libya.

The most dominant families were Chenopodiaceae (20 %), followed by Fabaceae (13 %) and Poaceae (10 %) (Table 4).

The eastern region is characterized by a more favorable climate condition, and thus more species were found (76 species) there in comparison to the rest of the country (Table 5).

Growth forms and plant parts used

Plant species were split into nine groups based on morphology (life form) and life span. The life form of the analyzed taxa exhibited a wide range of variation. Life form, which was divided into nine classes, took into account the growth of higher plants resulting from tissue initiation at the apices. Among which chamaephyte, a perennial plant that sets its dormant vegetative buds just at or above the surface of the ground; geophyte, a perennial plant that propagates by underground bulbs or tubers or corms; phanerophyte, the surviving buds or shoot apices are borne on shoots which projected into the air. Therophyte plants completed their life cycle from seed to seed and died. More than 50 species (36 %) were classified as Phanerophytes or shrubs, followed by trees and perennial forbs (Table 6).

The biodiversity delineated above is fundamental to the livelihoods of local communities, especially those residing in mountainous, arid, and semi-arid regions. This biodiversity encompasses a wealth of medicinal and other useful plants that enhance the healthcare of humans and livestock in rural areas [24]. If well-managed, these species represent good opportunities to increase and diversify the incomes of many people, as the demand for these species is increasing at both the national and international levels. The economic uses of the major collected species were recorded after consultation with local communities, experts, and several other sources (Table 7).

For the primary needs of health care, more than 80% of the world population depends on traditional medicine [22]. Our results confirm the report of WHO [29] indicating that medicinal plants are used

Table 2: List of multi-purpose plants and their uses collected during the collection missions of the Mediterranean coast of Libya in the spring and summer of 2009 and 2010

Scientific name	Author	Common name	Uses
Acacia cyclops	A. Cunn. ex G. Don	Coastal wattle	AF, FP, IP (tannin production)
Acacia farnesiana	(L.) Willd.	Sweet acacia	AF, MP, HF, OP, FP
Acacia Karroo	Hayne	Sweet thorn	AF, FP, IP, SF
Acacia ligulata	A.Cunn. ex Benth.	Umbrella bush	AF, FP
Acacia neriifolia	A.Cunn. ex Benth.	Oleander wattle	AF, FP, SHP
Acacia nilotica	(L.) Delile	Babul acacia	AF, MP, HP, IP (tannin, gum, wood)
Acacia oswaldii	F. Muell.	Umbrella acacia	AF, FP
Acacia salign	(Labill.) H. L. Wendl.	Milkweed	AF, MP, HF, EC, FP, BP
Acacia sclerosperma	F. Muell.	Silver bark wattle	AF, FP, WB, EC
Acacia tortilis	(Forssk.) Hayne	Umbrella thorn Acacia	AF, FP, EC
Acacia victoriae	Benth.	Bramble wattle	AF, IP, EC, WB
Aeluropus lagopoides	(L.) Thwaites	Mamoncillo	AF, IS
Alcea rosea	L.	Hollyhock	HF, MP, OP
Amaranthus hybridus	L. Engl	Smooth pigweed	AF, MP
Anabasis articulata	(Forssk.) Moq.	Jointed anabasis	MP, IP (soap)
Anvillea garcini	(Burm.f.) DC.	Guayache	AF, MP
Arbutus pavarii	Pamp.	Guitarfish	AF, HF, MP, FP, BP
Argania spinosa	(L.) Skeels.	Argan	MP, IP (argan oil)
Argyrolobium uniflorum	(Decne.) Jaub. & Spach		ISF, SF
Arnebia tetrastigma	Forssk.		AF, MP
Artemisia campestre	L.	Wormwood	SF
Artemisia herba-alba	Asso	Wormwood	AF, MP, FP, AP
Arthrocnemum glaucum	(Del.) Ungern-Sternb.	Glasswort	IS
Arthrocnemum perenne	(Mill.) Moss.	Chickenclaws	IS
Asparagus aphyllus	L.	Prickly asparagus	MP
Asparagus stipularis	Forssk.	Thorny asparagus	HF
Atriplex halimus	L.	Saltbush	AF, HF, SF, HP, EC
Atriplex leucoclada	Boiss.	Saltbush	AF
Atriplex nummularia	Lindl.	Old man saltbush	AF, OP, EC, HP
Atriplex semibaccata	R.Br.	Australian saltbush	AF
Balanites aegyptiaca	(L.) Del.	Egyptian balsam	MP
Bassia indica	(Wight) A.J.Scott.	Indian bassia	AF, SF
Bassia muricata	(L.) Asch.	Five-spine-bassia	AF, SF
Bassia scoparia	(L.) A.J. Scott.	Fireweed. kochia	AF
Blackiella inflata	(F. Muell.) Aell.)	Little saltbush	AF, SF, IS
Caesalpinia gilliesii	(Hook.) D. Dietr.	Yellow bird of paradise	OP, ISF
Calligonum arich	Le Houér.	Arta	AF, MP, SF
Calligonum comosum	L'Hér.	Abal	AF, MP, SF
Capparis spinosa	L.	Common caper	AF, MP, HF, EC, BP
Carthamus lanatus	L.	Saffron thistle	MP
Ceratonia siliqua	L.	Carob	AF, MP, FP, IP, SHP
Chenopodium murale	L.	Australian-spinach	MP
Cistus salvifolius	L.	Snow fountain	OP, IP (essential oil)
Citrullus colocynthis	(L.) Schrader	Bitter cucumber	MP
Cleome arabica	L.	Tamachek	AF, MP
Cupressus sempervirens var. dupreziana	(A. Camus) Silba	Tarout	AFFP, AP, IP (wood)
Cyperus rotundus	L.	Nut grass	MP
Dactylis glomerata subsp. *hispanica*	(Roth) Nyman	Barnyard grass	AF
Datura innoxia	Mill.	Jimson weed	MP
Deverra tortuosa	(Desf.) DC.	Loder's gazelle	MP, HF (soup powder), IP (essential oil)
Dodonaea viscosa	(L.) Jacq.	Hopbush	OP, HP
Ecballium elaterium	(L.) A. Rich.	Squirting cucumber	MP
Enchylaena tomentosa	R.Br.	Ruby salt bush	AF, MP
Ephedra alata	Decne.	White shrubby	AF, MP
Eryngium campestre	L.	Sea holly	AF, MP
Euphorbia dendroides	L.	Tree spurge	OP
Fagonia microphylla	Pomel		MP
Festuca arundinacea	Schreb.	Tall fescue	AF
Globularia alypum	L.	Cebollada	MP
Halocnemum strobilaceum	(Pall.) M. Bieb.	Yan jie mu	MP
Haloxylon articulatum	(Moq.) Bunge	R'meth	FP
Haloxylon salicornicum	(Moq.) Bge.	Saxaul	FP
Hammada schmittiana	(Pomel) Botsch.	Wormwood subdesertic steppes	AF, SF
Hammada scoparia	(Pomel) Iljin		FP
Haplophyllum tuberculatum	(Forsk.) Juss.	Oarn el-gazal	MP, IR, FP
Helianthemum lippii	(L.) Dum.Cours.	Sun-rose plants	AF

Table 2: Continue

Hyparrhenia hirta	(L.) Stapf	Coolatai grass	AF, EC
Imperata cylindrica	(L.) Raeuschel	Cogongrass	AF, MP
Juniperus phoenicea	L.	Phoenician juniper	AP, IP (cosmetic uses, essential oil), AFFP
Kickxia aegyptiaca	(L.) Nábelek		AF
Launaea nudicaulis	(L.) Hooker fil.	Bold-Leaf launaeae	MP
Lavandula multifida	L.	Fernleaf lavender	MP, AP, BP
Lawsonia inermis	L.	Henna	MP, IP (henna)
Limoniastrum guyonianum	Dur. ex Boiss.	Limoniastrum	AF, IS
Limonium lobatum	(L. f.) Chaz.	Grow Sea lavender	IS
Limonium pruinosum	L.	Frosty sea lavender	IS
Limonium tubiflorum	(Del.) O. Kuntze		IS
Lonicera etrusca	Santi	Honeysuckle	BP, AP, OP
Lycium shawii	Roem. & Schult.	Awsaj	MP, SS
Lygeum spartum	Loefl. ex L.	Lygeum	AF
Macrochloa tenacissima	(Loefl. ex L.) Kunth	Esparto grass	SF, EC, IP (paper)
Maireana brevifolia	(R.Br.) Paul G.Wilson	Blue bush	AF
Marrubium alysson	L.	White horehound	MP
Marrubium vulgare	L.	Horehound	FAA, BP, OP, MP
Matricaria aurea	(Loefl.) Sch. Bip.	Golden chamomile	MP, AP, IP (cosmetic product, essential oil chamomile)
Mesembryanthemum nodiflorum	L.	Senderleaf ice plant	MP
Moricandia arvensis	(L.) DC.	Violet cabbage	MP, HF, OP
Myrtus communis	L.	Common myrtle	MP, OP, AP, FP
Neurada procumbens	L.	Camel's thorn	MP, HF (Bedouin)
Nicotina glauca	R. Graham	Tree tobacco	MP
Nitraria retusa	(Forsk.) Asch.	Salt tree	MP, AF
Noaea mucronata	(Forssk.) Asch. & Schweinf		AF, FP, EC
Ocimum basilicum	L.	Sweet basil	AP, MP, OP, AF, HF (mild flavor in vegetable)
Olea europea var. oleaster	(Hoffmgg. & Link) D. C	Wild olive	GS, IP, MP
Panicum turgidum	Forssk.	Harmal shrub	AF, MP, EC, HF, SF
Parkinsonia aculeata	L.	Jerusalem thorn	AF, MP, OP, FP, BP
Peganum harmala	L.	Harmal shrub	MP
Pennisetum ciliare	(L.) Link	Buffelgrass	AF
Pennisetum setaceum	(Forssk.) Chiov.	Fountaingrass	AF
Pergularia tomentosa	L.	Baram-milk	MP
Periploca laevigata	Ait.	Periploca of the woods	AF, MP, OP
Phagnalon rupestre	(L.) DC.	Rock phagnalon	MP
Phalaris truncata	Guss. ex Bertol.	Canary grass	AF
Phillyrea angustifolia	L.	False olive	OP, AP
Phlomis floccosa	D. Don		MP
Piptatherum miliaceum	(L.) Coss.	Smilograss	AF
Pistacia atlantica	Desf.	Mount atlas pistache	AF, FAA, MP, FP, IP (gum)
Pistacia lentiscus	L.	Mastic tree	AF, MP, FP, IP (gum/resin)
Pituranthos tortuosus	(DC.) Benth. ex Asch. & Schweinf		MP
Plantago lanceolata	L.	Narrow-leaf plantain	AF, MP
Polygonum equisetiforme	Sm.	Horse-tail khotweed	AF, MP
Prosopis juliflora	(Sw.) DC.	Algaroba	AF, FP
Reaumuria vermiculata	L.	Molleih, hong sha shu	MP (for human and animal)
Retama raetam	(Forsk.) Webb et Benth.	White broom	AF, SF, MP, FP
Rhamnus lycioides subsp. oleoides	(L.) Jahand. & Maire	Arçot	OP, AF
Rhanterium suaveolens	Desf.	A'rfej	SF
Ricinus communis	L.	The castor oil plant	MP, IP (castrol oil), AF
Rumex pictus	Forssk.	Dock. hebrew	MP, HF
Ruta chalepensis	L.	Aleppo rue	AF, MP
Salicornia fruticosa	(L.) A. J. Scott	Glasswort	IS
Salsola delileana	Botsch.		AF
Salsola kali	L.	Prickly saltwort	AF
Salsola longifolia	Forssk.		AF
Salsola tetragona	Del.		AF, FP
Salsola tetrandra	Del.		AF, FP, IS
Salvia fruticosa	Mill.	Greek sage	AP, MP, IP (essential oil), HF
Sarcopoterium spinosum	(L.) Spach	Thorny burnet	MP, HP, FP
Satureja thymbra	L.	Pink savory	MP, AP, BP
Scirpus littoralis	Schrad.	Three-square bulrush	AF, IS
Scrophularia canina	L.	French figwort	MP
Searsia tripartita	(Ucria) Moffett.	Sumac	AF, IP (tanning), HF, FP
Simmondsia chinensis	(Link) Scheneider	Jojoba	MP, FP
Spartium junceum	L.	Spanish broom	AF, MP, AP, BP, OP
Stipa legascae	Roem. & Schult.	Feather grass	AF, SF

Table 2: Continue

Stipagrostis plumosa	(Linn.) Munro	Desert grass	AF
Stipagrostis pungens	(Desf.) De Winter	Three-awn grass	SF, IP (tent, basket, carpet, shoes)
Suaeda sp.			IS
Suaeda vera	Forssk. ex JF Gmel.	Swejda	IS
Suaeda pruinosa	Lange.	Risultati della ricerca	IS
Suaeda vermiculata	Forssk.	Sea-blight	IS
Tamarix boveana	Bunge	Tamariu alacantí	SF, HP, AF
Tamarix sp.		Tamarix	SF, HP, AF
Tetraena alba	(L. f.) Beier & Thulin	Syrian bean caper	MP, IP (medicinal soap), IS
Teucrium polium	L.	Felty germander	AF, MP, EC, AP, BP
Thymelea hirsuta	(L.) Endl.	Hairy thymelaea	SF, MP, IP (fiber)
Thymus capitatus	(L.) Hoffmanns. & Link	Conehead-thyme	AF, MP, HF, BP, EC
Traganum nudatum	Del.		FP, IS
Trifolium repens	L.	White clover	AF, ISF
Typha domingensis	Pers.	Narrow-leaved Cumbungi	OP, MP, HF, IP
Viburnum tinus	L.	Laurustinus viburnum	HP
Ziziphus lotus	(L.) Desf.	Lotus jujube	AF, MP, BP, HF (acid drink)

Abbreviations:

AF = Animal Feed	OP = Ornamental Plant	SHP = Shade Plant	SF = Sand Fixation
HF = Human Food	BP = Bee Plant	IR = Insect Repellent	WB = Wind Break
MP = Medicinal Plant	EC = Erosion Control	AFFP = Afforestation	FAA = Food Additives
FP = Fuel Plant	IP = Industry Plant	ISF = Improve Soil Fertility	IS = Indicator of Soil Salinity
AP = Aromatic Plant	HP = Hedge Plant	SS = Soil Stabilization	GS = Graft Stock

Table 3: List of plant communities per geomorphological zones

Geormorphological zones	Plant communities
Forest	*Juniperus phoenicea* and *Pistacia lentiscus*
	Juniperus phoenicea
	Searsia tripartita and *Periploca laevigata*
	Arbutus pavarii
	Ceratonia siliqua and *Pistacia lentiscus*
	Arbutus pavarii and *Juniperus phoenicea*
	Sarcopoterium spinosum and *Pinus halepensis*
Valleys (wadis)	*Juniperus phoenicea* and *Pistacia lentiscus*
	Atriplex nummularia and *Suaeda vera*
	Ziziphus lotus
	Capparis spinosa and *Nicotina glauca*
	Acacia farnesiana and *Acacia victoriae*
	Retama raetam and *Imperata cylindrica*
Rangelands	*Atriplex nummularia* and *Periploca laevigata*
	Acacia victoriae
	Macrochloa tenacissima and *Pistacia lentiscus*
	Aeluropus lagopoides and *Pituranthos tortuosus*
	Atriplex halimus
	Retama raetam
	Haloxylon salicornicum
	Haloxylon articulatum and *Lavandula multifida*
	Artemisia herba-alba and *Ziziphus lotus*
	Ziziphus lotus and *Lycium shawii*
	Thymelea hirsuta and *Atriplex halimus*
	Haloxylon salicornicum
	Stipagrostis pungens
Sabkha	*Retama raetam*
	Aeluropus lagopoides and *Pituranthos tortuosus*
	Thymelea hirsuta
Sand dunes	*Retama raetam* and *Ziziphus lotus*
	Retama raetam and *Panicum turgidum*
	Artemisia campestre and *Stipagrostis pungens*
Road sides	*Acacia Karroo*
	Atriplex halimus
Sea sides	*Pistacia lentiscus* and *Euphorbia dendroides*
	Chenopodium murale

throughout the world as home remedies, over the counter drug products and raw materials for pharmaceutical industries. For instance, trees such as pods and roots of *Acacia tortilis* are used to treat skin infections, allergic dermatomes, and as a vermifuge; *Parkinsonia aculeata* is used as an antipyretic and to treat diabetics; pods of *Ceratonia siliqua* are used as a laxative and have demulcent qualities. Leaves and flowering tops of *Coridothymus capitatus* are used as a bronchoantispasmodic and to treat asthma. Other herbs, such as *Datura inoxia*, are used as antispasmodics, narcotics, and hypnotics. Seeds of *Citrullus colocynthis* induce abortion, and are used as

Table 4: Number of species of the most dominant families sound during the collection missions of Mediterranean coast of Libya during the spring and summer of 2009 and 2010

Family	Species	%
Chenopodiaceae	31	20
Fabaceae	19	13
Poaceae	15	10
Lamiaceae	9	6
Asteraceae	8	5
Zygophyllaceae	4	3
Plumbaginaceae	4	3

Table 5: Number of collection sites and species per geographic area.

Geographic area	Sites	Species	Medicinal species
Eastern area	48	76	44
Western area	30	65	33
Middle area	1	10	1
Total	79	151	78

Table 6: Number of species in each life form for all species collected during the collection missions of Mediterranean coast of Libya during the spring and summer of 2009 and 2010

Life form	Number of species	%
Trees	24	16
Phanerophyte (shrubs)	55	36
Chamaephyte (semi-shrubs)	11	7
Annual shrubs	4	3
Perennial forbs	24	16
Perennial grasses	17	11
Biennial forbs	2	1
Therophyte (annual forbs)	11	8
Climbers	3	2
Total	151	100

Table 7. Economic uses of the major collected species in Libya.

Species	Animal feed	Human food	Medicinal	Fuel	Bee forage	Aromatic	Ornamental	Erosion control	Dune fixation	Hedge	Shade	Afforestation	Soil improver	Food additive	Industrial uses
Acacia cyclops	√		√	√				√	√				√		
Acacia farnesiana	√			√	√		√	√	√				√	√	√
Acacia victoriae	√		√	√									√	√	√
Balanites aegyptiaca	√	√	√	√				√	√						
Capparis spinosa	√		√		√									√	√
Ceratonia siliqua	√	√	√	√			√				√			√	√
Parkinsonia aculeata	√	√	√	√	√		√	√							
Prosopis juliflora	√			√	√			√	√		√	√			√
Searsia tripartita	√	√	√	√		√								√	√
Spartium junceum			√		√		√	√				√		√	√
Ziziphus lotus	√		√	√	√			√		√				√	

Table 8: List of medicinal plants collected from Mediterranean coast of Libya during the spring and summer of 2009 and 2010

Scientific name	Author	Family	Life-form
Acacia farnesiana	(L.) Willd.	Fabaceae	Tree
Acacia nilotica	(L.) Delile	Fabaceae	Tree
Acacia salign	(Labill.) H. L. Wendl.	Fabaceae	Tree
Acacia tortilis	(Forssk.) Hayne	Fabaceae	Tree
Alcea rosea	L.	Malvaceae	Biennial forb
Amaranthus hybridus	L. Engl	Amaranthaceae	Therophyte
Anabasis articulata	(Forssk.) Moq.	Chenopodiaceae	Phanerophyte
Anvillea garcini	(Burm.f.) DC.	Asteraceae	Perennial forb
Arbutus pavarii	Pamp.	Ericaceae	Tree
Argania spinosa	(L.) Skeels.	Sapotaceae	Tree
Arnebia tetrastigma	Forssk.	Boraginaceae	Perennial forb
Artemisia herba-alba	Asso	Asteraceae	Phanerophyte
Asparagus aphyllus	L.	Asparagaceae	Climber
Asparagus stipularis	Forssk.	Asparagaceae	Phanerophyte
Balanites aegyptiaca	(L.) Del.	Balanitaceae	Tree
Calligonum arich	Le Houér.	Polygonaceae	Phanerophyte
Calligonum comosum	L'Hér.	Polygonaceae	Phanerophyte
Capparis spinosa	L.	Capparaceae	Phanerophyte
Carthamus lanatus	L.	Asteraceae	Perennial forb
Ceratonia siliqua	L.	Fabaceae	Tree
Chenopodium murale	L.	Chenopodiaceae	Therophyte
Citrullus colocynthis	(L.) Schrader	Cucurbitaceae	Perennial forb
Cleome arabica	L.	Capparaceae	Perennial forb
Cyperus rotundus	L.	Cyperaceae	Perennial forb
Datura innoxia	Mill.	Solanaceae	Therophyte
Deverra tortuosa	(Desf.) DC.	Apiaceae	Phanerophyte

Table 8: Continue

Ecballium elaterium	(L.) A. Rich.	Cucurbitaceae	Perennial forb
Enchylaena tomentosa	R.Br.	Chenopodiaceae	Phanerophyte
Ephedra alata	Decne.	Ephedraceae	Phanerophyte
Eryngium campestre	L.	Apiaceae	Perennial forb
Fagonia microphylla	Pomel	Zygophyllaceae	Chamaephyte
Globularia alypum	L.	Globulariaceae	Perennial forb
Halocnemum strobilaceum	(Pall.) M. Bieb.	Chenopodiaceae	Phanerophyte
Haplophyllum tuberculatum	(Forsk.) Juss.	Rutaceae	Perennial forb
Launaea nudicaulis	(L.) Hooker fil.	Asteraceae	Perennial forb
Lavandula multifida	L.	Lamiaceae	Phanerophyte
Lawsonia inermis	L.	Lythraceae	Tree
Lycium shawii	Roem. & Schult.	Solanaceae	Phanerophyte
Marrubium alysson	L.	Lamiaceae	Perennial forb
Marrubium vulgare	L.	Lamiaceae	Perennial forb
Matricaria aurea	(Loefl.) Sch. Bip.	Asteraceae	Therophyte
Mesembryanthemum nodiflorum	L.	Aizoaceae	Therophyte
Moricandia arvensis	(L.) DC.	Brassicaceae	Chamaephyte
Myrtus communis	L.	Myrtaceae	Tree
Neurada procumbens	L.	Neuradaceae	Therophyte
Nicotina glauca	R. Graham	Solanaceae	Phanerophyte
Nitraria retusa	(Forsk.) Asch.	Zygophyllaceae	Phanerophyte
Ocimum basilicum	L.	Lamiaceae	Therophyte
Olea europea var. oleaster	(Hoffmgg. & Link) D. C	Oleaceae	Phanerophyte
Panicum turgidum	Forssk.	Poaceae	Perennial grass
Parkinsonia aculeata	L.	Fabaceae	Tree
Peganum harmala	L.	Zygophyllaceae	Perennial forb
Pergularia tomentosa	L.	Asclepiadaceae	Climber
Periploca laevigata	Ait.	Asclepiadaceae	Phanerophyte
Phagnalon rupestre	(L.) DC.	Asteraceae	Chamaephyte
Phlomis floccosa	D. Don	Lamiaceae	Perennial forb
Pistacia atlantica	Desf.	Anacardiaceae	Tree
Pistacia lentiscus	L.	Anacardiaceae	Tree
Pituranthos tortuosus	(DC.) Benth. ex Asch. & Schweinf.	Apiaceae	Chamaephyte
Plantago lanceolata	L.	Plantaginaceae	Perennial forb
Polygonum equisetiforme	Sm.	Polygonaceae	Perennial forb
Reaumuria vermiculata	L.	Tamaricaceae	Chamaephyte
Retama raetam	(Forsk.) Webb et Benth.	Fabaceae	Phanerophyte
Ricinus communis	L.	Euphorbiaceae	Annual shrub
Rumex pictus	Forssk.	Polygonaceae	Therophyte
Ruta chalepensis	L.	Rutaceae	Perennial forb
Salvia fruticosa	Mill.	Lamiaceae	Perennial forb
Sarcopoterium spinosum	(L.) Spach	Rosaceae	Phanerophyte
Satureja thymbra	L.	Lamiaceae	Chamaephyte
Scrophularia canina	L.	Scrophulariaceae	Chamaephyte
Simmondsia chinensis	(Link) Scheneider	Simmondsiaceae	Phanerophyte
Spartium junceum	L.	Fabaceae	Phanerophyte
Tetraena alba	(L. f.) Beier & Thulin	Zygophyllaceae	Phanerophyte
Teucrium polium	L.	Lamiaceae	Chamaephyte
Thymelea hirsuta	(L.) Endl.	Thymelaeaceae	Phanerophyte
Thymus capitatus	(L.) Hoffmanns. & Link	Lamiaceae	Phanerophyte
Typha domingensis	Pers.	Typhaceae	Perennial grass
Ziziphus lotus	(L.) Desf.	Rhamanaceae	Phanerophyte

a laxative and a vermifuge. Leaves and flowers of *Marrubium alysson* are used for colds, coughs, and asthma. Seventy-eight species with medicinal benefits were found across the Libyan Mediterranean Coast (Table 8). As was previously reported, such medicinal plants have important commercial value as they represent a key source of income for many rural households. Yet, despite their significance, this sector remains marginal and traditional, characterized by a limited number of cultivated species. In light of the encroachment of desertification as well as limited water resources, developing the cultivation of medicinal plants rather than water-demanding crops will contribute to the better management of limited natural resources. Indeed, indigenous medicinal plants are better adapted to the local environment, even under stressful conditions.

Among the medicinal plants, the Lamiaceae, Fabaceae, and Asteraceae families were the most prevalent, accounting for 12, 10, and 8 %, respectively, of the total (Figure 3). With regard to the biological spectrum for the visited sites, data indicated that Phanerophytes (shrubs) and perennial forbs were the most dominant life-form type, representing more than 55 % of all species encountered during the collection missions (Figure 4).

Major medicinal plants were organized into three classes depending on their families, life form, used parts, and types of uses (Boukef, 1986; El-Darier and El-Mogaspi, 2009). The medicinal uses of different plant species are given in Table 9.

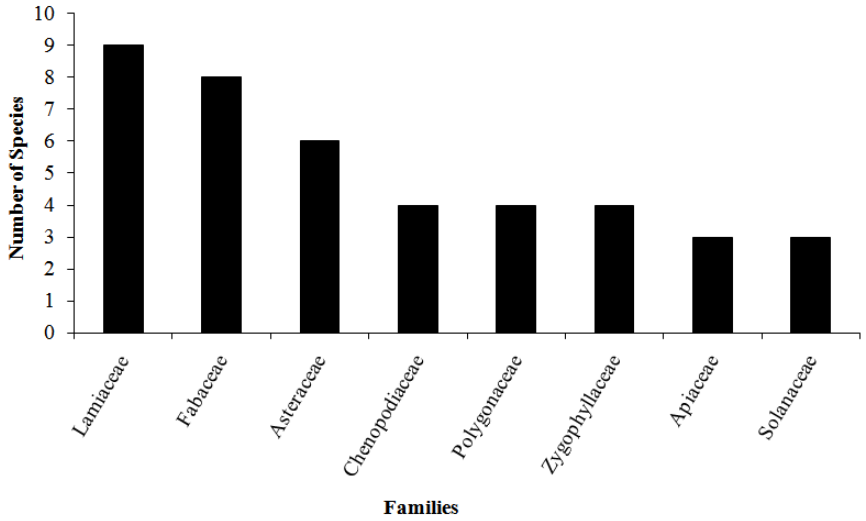

Fig. 3: Number of species encountered for the main families found during the collection missions of Mediterranean coast of Libya during the spring and summer of 2009 and 2010

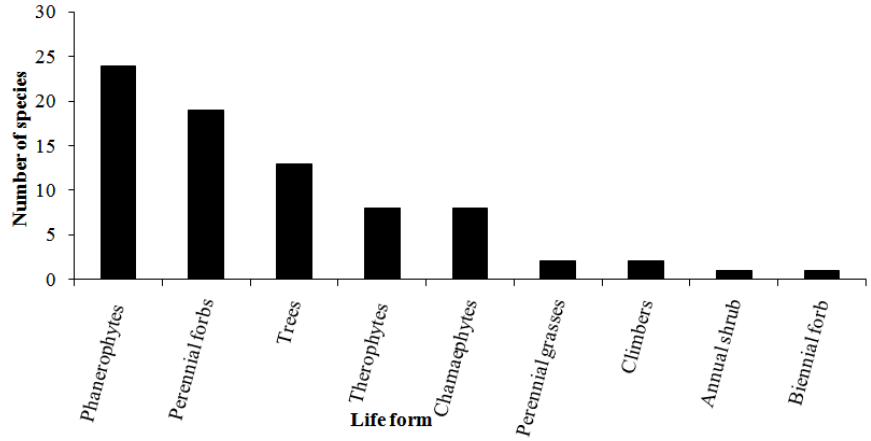

Fig. 4: Number of species sorted based on life-form during the collection missions in 2009 and 2010 in the Mediterranean coast of Libya

Table 9: Plant part used and medicinal uses of the major medicinal plants recorded during the collection missions in Libya

Species	Part used	Medicinal use
Acacia tortilis	Pods and roots	Treat skin infections, allergic dermatomes
Parkinsonia aculeata	Aerial parts	Antipyretic and to treat diabetics
Ceratonia siliqua	Pods	Laxative and have demulcent qualities
Argania spinosa	Oil of seeds	lowers blood pressure
Periploca laevigata	The root powder	Treat dyspepsia, constipation and hepalosplenomegales
Thymus capitatus	Leaves and flowering tops	Bronchoantispasmodic and to treat asthma
Searsia tripartita	Seeds	Stomach disease
Ruta chalepensis	Aerial parts	Anti-inflammatory, antipyretic, analgesic
Deverra tortuosa	Leaves, roots and stem extracts	Potential nutritional and antifungal uses
Halocnemum strobilaceum	Oil of seeds	Applied on head for hair loss
Sarcopoterium spinosum	Roots	Treat stomachaches, toothache, gingivitis, oligouria
Tetraena alba	Plant extracts	Therapeutic use; Wounds healing, dental caries, diabetes
Lavandula mutifida	Oil from flower	Antiseptic and aromatherapy
Datura inoxia	All parts of plants	Antispasmodic, narcotic and hypnotic
Citrullus colocynthis	incite abortion	Laxative and vermifuge
Marrubium alysson	Leaves and flowers	Used against colds, coughs and asthma
Carthamus lanatus	Aerial parts	Anti-inflammatory and analgesic effect
Cleome arabica	Leaves	Arthritis, rheumatism
Mesembryanthemum nodiflorum	Seeds	Antipoetic
Typha domingensis	Rootstocks	Used as a diuretic for increasing urination
Rumex pictus	Roots, stem, fruits, leaves	Sedative, spasmogenic

Conclusion and Recommendations

This initial assessment of the status of medicinal plants has confirmed the vast richness of the plant biodiversity of Libya, which furnishes an incredible array of traditional uses with high economic potential. From an ecological point of view, medicinal plants are well adapted to dry conditions, consume less water than most crops, and offer considerably higher returns. If effectively developed, the industry could substantially improve the livelihoods of a large number of the rural poor. The diagnostic assessment of the current medicinal plants sector in Libya revealed several deficiencies, however, and to promote this sector the following recommendations are offered for the consideration of those parties involved, either directly or indirectly, in the production and commercialization of medicinal plants in Libya:

Establish a national strategy for the promotion of medicinal plants in Libya.

Support the conservation, management, and sustainable utilization of medicinal plants in Libya through conservation, cultivation, and propagation.

Promote *in situ* conservation of precious genetic resources that are threatened by human encroachment and climate change.

Compile a national database on indigenous medicinal plants in order to assess their use, status, and means of cultivation.

Promote the domestication and cultivation of new medicinal plants to help reduce the over-exploitation of plant biodiversity in natural habitats.

Establish extension programs on the importance and conservation of medicinal plants for rural people.

Develop a clear policy for the protection, production, transportation, and marketing of raw medicinal plant materials that is sensitive to the needs of the rural poor, who depend upon such natural resources for income.

Improve public awareness of the importance of medicinal plants, and build on traditional knowledge and cultural heritage.

Establish or strengthen market linkages for small farmers by working with small and medium sized-enterprises, traders, and other market intermediaries involved in medicinal plants.

Conduct value-chain analyses of medicinal plants so as to understand constraints along the chain and thereby identify opportunities for value-added benefits to small growers as well as the capacity-building needs; investment gaps; and policy, institutional, and marketing issues that must be addressed.

Acknowledgments

The authors greatly appreciate the support of the Libyan government in funding this research, along with the invaluable assistance and cooperation provided by the Agricultural Research Center, the Libyan genebank in Tripoli, and many colleagues and friends.

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