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Ethnobotanical and Economic Importance of Wild Plant Species of Jabal Moussa Bioreserve, Lebanon

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Abstract

Wild plants are among the important service forests provide to man. In this study, an ethnobotanical survey of the wild plants of Jabal Moussa Bioreserve of Lebanon has been conducted through personal interviews with key community members of the bioreserve villages. The economic importance of cited ethnobotanical species was then assessed based on the commercial value of species and their relationship to economic crops. The findings revealed that 130 plant species provide the local community with a breadth of wood and non-wood products. Medicinal species ranked highest contributing to 33% of reported use followed by food and beverage (15%), fuel (12%), environmental uses (10%) and materials (8%), while the remaining 22% was shared between other uses (bee plants, poisons, cosmetics, and social uses). Based on their use-values, *Ceratonia siliqua, Laurus nobilis, Prunus* sp.and *Rhus coriaria* were among the highest-ranking tree species. Whereas, *Cichorium intybus, Eryngium creticum, Gundelia tournefortii, Matricaria chamomilla, Melissa officinalis, Origanum* sp., *Salvia fruticosa* and *Viola odorata* were at the forefront of herbaceous species. Considering the commercial value and relationship to economic crops, the results demonstrated a list of 21 species of actual and potential high economic importance. Findings of this study clearly indicate that numerous wild plants of Jabal Moussa Bioreserve are still in use and hold high potentiality for economic development. Further studies to map and quantify the availability of these species and develop suitable methods for their propagation and production are necessary.

Keywords: Ethnobotany; Economic Importance; Wild plants; Jabal Moussa Biosphere; Lebanon

Introduction

Since time immemorial, thousands of wild plant species offer various significant economic, social and ecological values which are of fundamental importance for human well-being, livelihood development and ecosystem resilience to environmental change [1,2]. In most societies and more especially in developing countries wild plants generate tremendous direct economic benefits being important source for significant marketed goods (food, medicinal plant, firewood, cork… etc) as well as indirect high value for non-marketed services (biodiversity conservation, soil protection, water regulation, recreation possibilities) [3,4].

Mediterranean forests have for a very long time played a fundamental role in people's lives during the various civilizations that have flourished in the Mediterranean region. They are well appreciated for the extraordinary variety of goods and services they offer, and communities they sustain. Soil and water protection, carbon sequestration, erosion and desertification control, biodiversity conservation, wild-life hosting, grazing and hunting, and recreational activities are some of the wealthy services provided [5-7].

As part of the East Mediterranean forests, Jabal Moussa Bioreserve (JMBR) in Lebanon has been designated by UNESCO Man and Biosphere program in 2009 as the 3rd biosphere reserve in the country. JMBR is a diverse mosaic ecological system of Eastern Mediterranean conifer-sclerophyllous-broad leaf forest. The biodiversity richness of the bioreserve flora encompasses a total of 717 plant species, 26 of which are endemic [8,9]. The high flora diversity indices varying between 25 and 65 plant species/100 m^2 in JMBR is considered among the highest values recorded in Lebanon [10]. JMBR constitutes an important source of economically valuable goods and services that form a key instrument in maintaining cultural traditions and building of social and economic capital for its surrounding vulnerable community. A wealth monetary benefit to locals such as ecotourism, grazing, charcoaling, handcrafts, food and some beekeeping are derived from JMBR. However, the natural regeneration of economically important plants can be adversely affected by anthropogenic pressure and climatic changes.

The cultural legacy of JMBR dating back to second century presents a unique example for human and nature interaction since time immemorial and qualifies the bioreseve as a rich den for indigenous traditional knowledge on the use and importance of wild plants. This traditional knowledge contains immense insight and a great potential as a useful basis for introducing modern innovative approaches to sustainable development and management of natural resources. This knowledge is also necessary to assist managers, decision makers and stakeholders to incorporate actual and potential valuable species into economic future planning, policy and investment. The present study was, therefore, initiated to identify plant species of high ethnobotanical and economic values that have the potential to support the resilience and security of local community.

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Materials and Methods

Study site

Situated on the western slopes of Mount Lebanon at the north of Lebanon, JMBR covers an area of 65 km^2 extending between the altitudes of 350 m and 1700 m (Figure 1). Spread on karstic landscapes and steep slopes, the sharp temperature and precipitation altitudinal gradients in JMBR have led to the formation of different climatic zones running along its elevations explaining its habitat diversity and species richness. With an annual precipitation average of 1,350 mm and mean humidity level of 58%, JMBR plays a key role in the water cycle of Mount Lebanon influencing climate and precipitation regimes and modulating the runoff regime. The mean daily maximum temperature is 26.5°C in August, whereas the mean minimum temperature is 3.5°C in January. Snow caps the summit of reserve for a very short period of winter, whilst mist is a frequent occurrence in summer. JMBR vegetation and soils store rainfall water and regulate the gradual flow of water and sediments downstream, which fertilizes agricultural plains, and recharges rivers and ground water aquifers in lowland areas. JMBR houses several villages the main of which are Chouene, Ebri, Broqta, Snobar, Yahchouch, Qehmez and Mchati. While the majority of the inhabitants of these villages (15,000) settle in urbanized centers close to the capital city of Beirut, elderly villagers representing only 20% of inhabitants are the permanent residents.

Ethnobotanical survey

Community information on the various aspects of plant use was collected during 2014-2016 in the villages of Chouene, Ebri, Broqta, Snobar, Yahchouch, Qehmez and Mchati. A semi-structured survey questionnaire using a freelisting approach was conducted with 93 (54 female and 39 males) native mid-age (around 55 years) local informants recognized for their distinguished knowledge on the plants of JMBR and their use. The use categories considered by Cook [11] were used to classify plant use. For practicality reasons and some uncertainty in the use categories of some species by indigenous communities, some categories were merged into three categories, i.e. vertebrate poisons and non-vertebrate poisons as poisons; food plants and food additives as food and additives; animal food and invertebrate food as fodder and forage.

Source: http://www.freeworldmaps.net/asia/lebanon/map.html

Figure 1: Geographical location of Jabal Moussa Bioreserve on Mount Lebanon Range, Lebanon.

The knowledge of informants was recorded by personal interviews during field walks and household meetings using fresh flourestic specimens. Floristic voucher specimens were collected and immediately pressed for precise identification using the taxonomic keys of Mouterde [8]. Nomenclature and plant family delimitation follows Euro+Med [12] as far as published with Compositae adapted to Asteraceae with the accepted names and family classification of The Plant List (http://www.theplantlist.org/) given (as synonyms) if deviating. Voucher specimens were deposited at the Herbarium of the Research Center for Environment and Development at Beirut Arab University.

The use-values based on the number of repeated and independent reports were used to describe the relative importance of plants to local people and compare the local importance of different species [13,14], as UV=∑U/n; where U is the number of use-reports of each species and n is the number of all informants.

Economic importance

The economic importance (EI) of informants reported species was then assessed by desk analysis using the scoring system of Catling et al. [15]. This scoring system computes EI as the average of "commercial value" of wild plant species and "relationship to economic plants", ranging between 1 (most important EI score) and 3 values. The socring values were determined based on the registry records and data available at the Ministry of Agriculture, Ministry of Economy and Trade and FAO-Lebanon Statistics Division (http://www.fao.org/faostat/en/), and available literature reporting the use of some wild plants in the country [16,17]. In assessing the "commercial value" of a species, major crops were those considered among the top national commodities of the country.

Results and Discussion

Cited species

In this study, informants consulted in JMBR villages reported the use of 130 wild species distributed in 58 families forming approximately 18.3% of the previously documented 717 species of the bioreserve [9]. As illustrated in (Figure 2), the life forms of species were distributed as 41% herbs, 30% shrubs, 25% trees and 4% climber indicating the remarkable importance of herbs as a major source of forest products.

Among the use categories of the cited plants, medicinal species ranked highest contributing to 33% of reported uses followed by food and beverage (15%), firewood and chacoal (12%), materials (8%) and environmental uses (10%), while the remaining 22% was shared among other uses (bee plants, poisons, cosmetics, and social uses) (Figure 3). In general terms, the contribution of non-timber products in this study , all categories (90%) excluding "materials", is in total agreement with the previous assessment of the values of non-timber forest products in the Mediterranean region with Lebanon being among the countries of

higest values (142 Euro/ha, 2005 prices) [6]. This may be due to the increased public awareness and efficient prohibition of logging by the Forest Code (Law 85 date 12/9/1991) during the last decade and the increased emphasis on non-wood services in JMBR such as nature conservation and wilderness set by JMBR management programs. It is worthy to note that these species are mostly native to Lebanon and the reported knowledge was based on the memory of informants and was orally transmitted between individuals and from generation to generation.

Out of the 130 species reported in this study (Table 1) shortlists 47 species recognized by nearly all informants to provide a breadth of wood and non-wood key products and therefore scored the top ranking use values (0.8-1.0). For each reported species, the scientific name, synonyms, plant family, English and local Arabic common names, and use categories are provided. The multipurpose use of most plants is a striking feature of the reported knowledge. For example, *Ceratonia siliqua*, *Laurus nobilis* and *Rhus coriaria* are used for food, fuelwood and charcoal, timber and herbal medicine which made them highest among the potential species for domestication, selection and improvement.

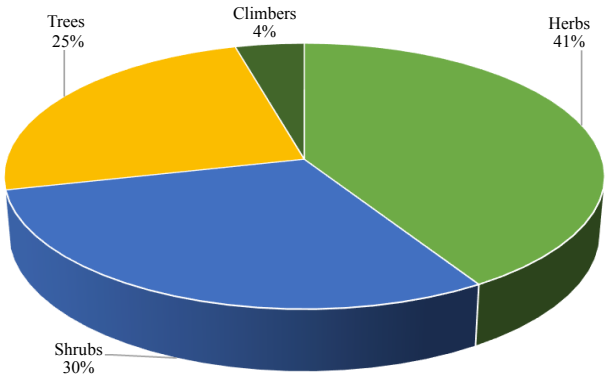

Figure 2: Life forms of species cited by JMBR informants for their ethnobotanical importance.

Ethnobotanical use

Medicinal use: The perpetual interest in the healing properties of JMBR wild plants was clearly reflected in the substantial contribution of cited medicinal species (33%) to the primary healthcare of locals and treatments. Wide range of ailments including infectious diseases, diabetes, wounds, digestive system, kidney stones, urinary tract system, fever and pain, and many other disorders were reported to be treated by many of JMBR wild plants. *Alcea setosa*, *Ecballium elaterium*, *Malva* sp., *Matricaria chamomilla*, *Melissa* sp., *Mentha* sp., *Micromeria* sp., *Origanum* sp *Saliva* sp. and *Viola odorata* stood as important examples for high use-value herbaceous species as all informants claimed their use for the medicinal purposes. The importance of this traditional knowledge lies on its role in the discovery of new sources of drugs and community health care systems. Medicinal and aromatic in Lebanon have recently been receiving the increasing attention of researchers, policy makers and development program for their importance in promoting livelihood and sustainable development strategies [18].

Food: Although local agricultural activities of domesticated vegetables and fruits chiefly satisfy the food needs of locals, significant quantities of JMBR wild plants were reported by informants to be still gathered and consumed as an integral component of delicious traditional Lebanese cuisine. *Centaurea calcitrapa, Cichorium intybus*, *Eryngium creticum, Malva* sp., *Portulaca oleracea* and many other mountain greens locally referred to as "Slieka" are eaten cooked with olive oil and flavoring fried onions and traditionally served with

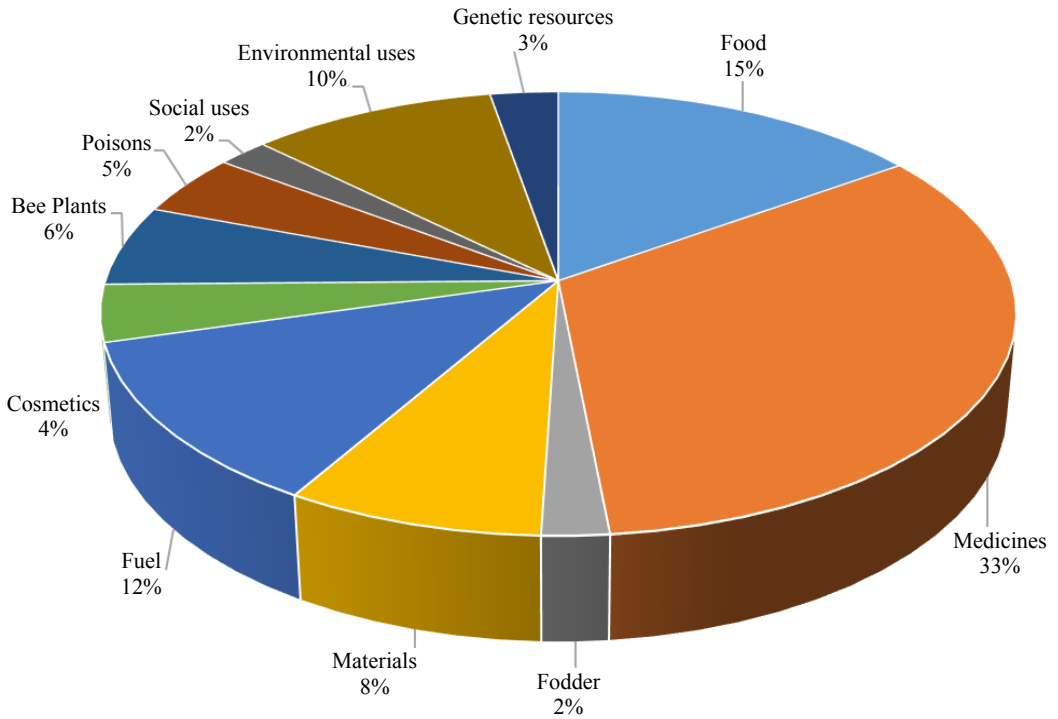

Figure 3: Percentage of different use-categories of reported ethnobotanical importance of JMBR plant species.

Family*	Plant species$^{\delta}$	English common name	Arabic common name	Ethnobotanical use categories^{+}										
				Fod	Fdr.	Med.	Mtr.	Fir.	Cos.	Mel.	Pos.	Soc.	Env.	Gen.
Amaryllidaceae	*Narcissus tazetta* L.	Bunch-Flowered Daffodil	Narjes			+							+	
Anacardiaceae	*Rhus coriaria* L.	Sumach	Sumac	+		+	+	+						
Apiaceae	*Eryngium creticum* Lam.	Cretan Eryngo	Kers A'nné	+		+								
Apiaceae	*Foeniculum vulgare* Mill.	Common Fennel	Choumar	+		+								
Asteraceae	*Centaurea calcitrapa* L.	Red Star-Thistle	Marar, Shawk el- Massieh	+						+				
Asteraceae	*Cichorium intybus* L.	Common Chicory	Hendbé	+		+								
Asteraceae	*Gundelia tournefortii* L.	Gundelia	A'akoub	+		+								
Asteraceae	*Matricaria chamomilla* L.	Wild Chamomile	Babounej	+		+			+					
	Matricaria recutita L.													
Brassicaceae	*Nasturtium officinale* (L.) R. Br.	Common Water-Cress	Kerra	+		+								
	[*Nasturtium officinale* R.Br.]													
Cucurbitaceae	*Ecballium elaterium* (L.) A. Rich.	Squirting Cucumber	Kett el-Hmaar			+					+			
Cupressaceae	*Juniperus drupacea* Labill.	Drupe-Bearing Arceuthos	Defran			+			+			+	+	
	Arceuthos drupacea (Labill.) Antoine &Kotschy													
Cupressaceae	*Juniperus oxycedrus* L.	Prickly Juniper	'Ar 'ar			+			+			+	+	
Fabaceae (Leguminosae)	*Ceratonia siliqua* L.Link	Carob	Kharroub	+		+	+	+						
Lamiaceae	*Melissa officinalis* L.	Common Balm	Hashishat en-Nahl	+		+				+				
Lamiaceae	*Mentha aquatica* L.	Water Minth	Na'ana'a Muyie	+		+								
Lamiaceae	*Mentha spicata* subsp. *condensata* (Briq.) Greuter & Burdet	Small-Leaved Mint	Na'ana'a Barri	+		+								
	Mentha microphylla K. Koch													
Lamiaceae	*Micromeria juliana* (L.) Benth. ex Rchb. *Micromeria juliana* (L.) Benth.	Linear-Leaved Savory	Zoufa			+								
Lamiaceae	*Origanum ehrenbergii* Boiss.	Ehrenberg's Marjoram	Za'atar Jabali	+		+								
Lamiaceae	*Origanum syriacum* L.	Syrian Marjoram	Za'atar Zouba'a	+		+				+	+			
Lamiaceae	*Salvia fruticosa* Mill.	Shrubby Sage	Kasa'een/ Maryamie'	+		+				+	+			
Lauraceae	*Laurus nobilis* L.	Laurel	Ghaar	+	+	+	+	+	+		+	+		
Liliaceae	*Lilium candidum* L.	Madona Lily	Zanbak Mar Yousef						+			+	+	
Malvaceae	*Alcea setosa* (Boiss.) Alef.	Holly Hocks	Khatmyie'	+		+								
	Alcea setosa palmata Zoh.													
Malvaceae	*Malva multiflora* (Cav.) Soldano and al.	Mallow	Khebayieze'	+		+								
	Lavatera cretica L.													
	[*Malva multiflora* (Cav.) Soldano, Banfi & Galasso]													
	Malva neglecta Wallr.		Khebayieze'	+		+								
	Malva nicaeensis All.		Khebayieze'	+		+								
	Malva sylvestris L.		Khebayieze'	+		+								
Moraceae	*Ficus carica* L.	Common Fig	Teen	+		+	+	+						+
Myrtaceae	*Myrtus communis* L.	Common Myrtle	Hembalss/ Rihan	+		+		+			+	+	+	
Orchidaceae	*Orchis anatolica* Boiss.	Anatolian Orchid	Sahlep	+										
Pinaceae	*Pinus brutia* Ten.	Calabrian Pine	Snawbar Brouti			+	+	+			+			
Platanaceae	*Platanus orientalis* L.	Oriental Plane	Delb				+	+					+	
Poaceae	*Hordeum bulbosum* L.	Bulbous Barley	Sh'aeer Barri	+	+									+
Portulacaceae	*Portulaca oleracea* L.	Common Purslane	Bakkle'	+		+								

Rosaceae	*Crataegus azarolus* L	Common Hawthorn	Za'arour	+		+		+						
Rosaceae	*Malus trilobata* (Lab.) C.K. Schneider	Three-Lobed Apple	Teffah Barri	+			+	+		+				
Rosaceae	*Prunus mahaleb* L.	Mahaleb	Mahalab	+		+	+	+		+				+
Rosaceae	*Pyrus syriaca* Boiss.	Syrian Pear	Injas Barri	+		+	+	+						+
Rosaceae	*Rosa canina* L.	Dog Rose	Ward Jouri	+		+							+	+
	Rosa corymbifera Borkh.	Thicket Rose	Ward Jouri	+		+	+						+	+
	Rosa dumetorum Thuill.													
	Rosa phoenicia Boiss.	Rambling Rose	Ward Jouri	+		+	+						+	+
Rosaceae	*Rubus praecox* Bertol.	Edible-Fruited Blackberry	Oulaik, Tout Barri	+		+							+	+
	Rubus hedycarpus Focke													
Rosaceae	*Rubus sanctus* Schreb.	Palestine Blackberry	Oulaik, Tout Barri	+		+							+	+
Rosaceae	*Sorbus torminalis* (L.) Crantz	Wild Service-Tree	Ghbiera			+	+	+					+	
Salicaceae	*Populus nigra* L.	Black Poplar	Howr Aswad				+	+	+					
Salicaceae	*Salix libani* Bornm.	Lebanese Willow	Safsaf Lebnani				+	+						
Violaceae	*Viola odorata* L.	Sweet Violet	Banafsaj			+			+					

*Family classification of Euro+Med PlantBase (2006-) with Compositae adapted to Asteraceae and families of the Plant List (2010-) (in brackets) if deviating . [δ]Nomenclature of Euro+Med PLantBase (2006-) and synonyms of Mouterde [8] and the accepted names of the Plant List (right angle brackets) if deviating. [+]abbreviations: Fod. (Food and beverage); Fdr. (Fodder); Med. (Medicine); Mtr. (Materials including timber, essential oils and others); Fir. (Firewood and charcoal); Cos. (Cosmetics); Mel. (Bee plant); Pos. (Poisons); Soc. (Social use); Env (Environmental use) and Gen. (Genetic resources).

Table 1: Ethnobotanical use categories of JMBR plant species.

Arabic bread "Markook or Saj". Two other characteristic popular edible species of the traditional Lebanese cuisine were *Gundelia tournefottii* "A'kub" and *Origanum syriacum* (Za'atar) as the most economic and edible wild plant in Lebanon has a long history of use. *Ceratonia siliqua* "Kharroub" is also considered by informants as one of the most useful edible species of the bioreserve and traditionally used for extracting molasses "debs" by mashing ground carob pods with water to extract syrup that is heat thickened and caramelized [19]. *Ficus carica* "Teen" as a fruit tree is also considered among the most popular edible for its fresh and dry fruits. Also, *Prunus mahaleb* is reported as popular for its famous the grounded kernels "mahlab" spice used in the preparation of many Lebanese pastries is reported as popular [17]. Considering the health benefits of plant-based traditional Lebanese food and its importance to household food and nutrition security [20], it is necessary to stress that wild edible plants and associated traditional food are more deeply integrated in food security and conservation strategies of the country.

Firewood and charcoal: Gathering firewood for daily domestic energy and charcoal production was still according to informants to some considerable extent practiced (12%). This is particularly important in view of the burdening economic pressure caused by the recent energy crises and increases in the prices of natural gas and oil in the country which is expected to revive interests in firewood. While all tree species of the bioreserve were cited to offer good firewood, *Juniperus drupacea, Juniperus oxycedrus*, *Platanus orientali*, *Populus nigra*, *Salix libani, Pinus brutia* and *Prunus* sp. were reported as unsuitable for high quality charcoal production. In spite of the lack of records on the monetary value of wood products of JMBR, the application of sustainable management practices has no doubt resulted in effective and efficient use of wood-products of the bioreserve, while conserving its ecosystem [21,22].

Environmental use

The contribution of JMBR wild plants to environmental uses was also reported as substantial (10%). Ornamental and hedge plants are important to locals who expressed distinguished appreciation to the aesthetic and recreational values of *Rhododendron ponticum, Lilium candidum*, *Paeonia kesrouanensis*, *Cyclamen* sp., *Juniperus drupacea, Juniperus oxycedrus* and *Ceratonia siliqua*. This wealth of wild native rare flowers may be suggested as one of the alternate method to maintain the unique diversity of the species and conserve the rare, endemic and endangered species of ornamental interest. On the other hand, some woody species such as *Prunus* sp. and *Ceratonia siliqua* are used within afforestation initiatives implemented in different sites in Lebanon [17].

Materials

The extraction of wood and non-wood materials such as timber, tannin, dyes and others appear to occupy considerable share of informants' reports (8%). While most of tree species, mainly *Q. calliprinos* were declared as suitable for timber production, several species were useful sources for a range of multiple materials, i.e. *Alnus orientalis* (agricultural tools); *Arbutus unedo* (dyes); *Rhus coriaria* (tannin and dyes); *Spartium junceum* (brooms, coarse fabrics, dyes); *Prunus* sp. (walking sticks), *Calicotome villosa*; *Ruscus aculeatus* and *Typha domingensis* (brooms and rags). Informants recalled that timber production used to be one of the most important service provided in the region for traditional house construction, furniture, agricultural tools, walking sticks, packaging boxes of fruits and vegetables. Nevertheless current restrictions on forest logging and prohibition of commercial timber harvesting as well as introduction of a wood substitute industry have played a major role in reducing timber extraction not only of JMBR but also all across the country. In spite of limitation in data availability, however, it is believed that the intensive timber and furniture importation from China, Indonesia, Turkey and Malaysia and South Africa has also played a role in reducing timber extraction of Lebanese forests and woodlands.

Bee plants

Considerably contribution of bee plants (6%) to local use of JMBR was reported. *Centaurea calcitrapa, Dittrichia viscosa*, *Eryngium creticum*, *Melissa officinalis, Origanum syriacum*, *Salvia fruticosa* and *Prunus* sp. were cited as excellent sources for nectar and, thus are

important for the production of high quality traditional Lebanese honey not only in JMBR but also in other regions of the country. Informants agreed that bee-keeping offers a high potential for sustainable livelihoods and could become an important source of regular incomes in spite of recent challenges facing the sector in the country causing the disruption and death of honeybees [23].

Poisonous species

In view of both their positive and negative uses, poisonous plants were also regarded by informants to considerably contribute (5%). The advantageous use of the essential oils or leaf fumigation of *Myrtus communis*, *Laurus nobilis*, *Origanum syriacum, Salvia sclarea* and *Salvia fruticosa* as insect repellents and insecticides against home insects and crop pests formed a good share of the informants' knowledge. The threat to human health and livestock caused by the most toxic plants *Ecballium elaterium, Nerium oleander* and *Spartium junceum,* was indicated by informants as overwhelming. Full awareness that a boundary line between beneficial and toxic properties of medicinal plants is not a clear-cut and many turn toxic in overdosing. Additionally, poisoning in livestock was mentioned to be more common with toxic introduced species such as *Lantana camara*. Due to the lack of documented records of cases and as the diagnosis of plant poisoning is not always simple, and depends on a treatment that is not always possible or successful, awareness of plant toxicity and prevention remain the most important way to protect humans and animals. Also, control of exotic invasive plants with toxic potential is also necessary in preventing poisoning and warrants especial attention in Lebanon.

Cosmetics and perfumery

The informants' favorable reported species for cosmetics and perfumery were *Laurus nobilis*, *Lilium candidum*, *Myrtus communis*, *Narcissus tazetta*, *Viola odorata*, *Juniperus drupacea*, *Juniperus oxycedrus*, and *Pinus brutia*. Essential oils, extracts and resins were the main forms used. These findings highlight the need to integrate cosmetics and perfumery plant production in livelihood development programs while identifying appropriate strategies and actions for biodiversity protection. This is particularly important as international consumers are becoming especially interested in ingredients of interesting traditional uses and local beauty rituals [24].

Genetic resources

JMBR contains a large array of plant genetic resources including crop wild relatives of *Hordeum*, *Aegilops*, *Avena*, *Pisum*, *Vicia* and others. Some fruit trees like *Prunus* sp. are exploited for seed harvesting for frequent use in nurseries as root-stocks for local cultivated varieties of plum and almonds. Moreover, it was common in this study to see wild pyrus trees grafted by local varieties for the production of edible fruits for the use of shepherds and local communities. These practices were previously reported in other regions of the country [17,25]. Nevertheless, informants had a little knowledge on the importance of these genetic resources although they recognize that their traditional varieties are progressively lost or replaced by new improved ones. In that context, the recently developed national strategy for plant genetic resources of Lebanon is addressing both institutions and farmers on the importance of preserving and sustainably managing plant genetic resources being the most valuable and essential basic raw materials to meet the current and future needs of crop improvement and breeding programs [26-28], thus in line with the requirements of the International Treaty on Plant Genetic Resources for Food and Agriculture (ratified by the government since 2004).

Fodder

The small share of plant uses (2%) was mainly based on shepherds' citation of species that were very well recognized for their high nutritive value, meat and milk production. These species are *Bituminaria bituminosa, Cynodon dactylon* and *Hordeum bulbosum* for livestock mainly goats. Informants also stressed the importance of all green wild grass and leafy species usually available during spring season to satisfy the livestock needs. Goats were indicated to commonly graze freely for 8 months of the year (roughly April to November). It follows, that from an economic perspective, the small share of the ethnobotanical species doesn't realistically reflect the importance of the wild plants to grazing, but rather identifies the plant species traditionally known as important forage to livestock. While grazing patterns vary significantly between regions, grazing was found to contribute to 13.20% of the total economic value of Turkish forests [29]. According to informants, livestock fodder plants were generally considered a conflicting demand as goat husbandry and dairy production were claimed as prevalent professions of the rural communities of JMBR and yet running an extensive damage to vegetation caused by grazing across all the bioreserve [30]. In spite of this conflicting issue, livestock production remains a very promising component and an integral part of the livelihood and traditional agricultural systems of JMBR rural communities, while the lack of sustainable grazing is inadequately practiced to support the pastoral system and the development of livestock production in the country [31,32].

Social use

As an intriguing component of traditional Lebanese religious and cultural practices, *Lilium candidum* and *Myrtus communis* were reported to be still in use at homes and local churches in the worships and divine blessings to cure and punish offenders against good long human life and expel of evil spirits. The frequencies in which these plants were used varied between informants, as they could be occasionally used only for parts of rituals to being frequently used in daily prayer. Particular emphasis was placed on *Lilium candidum* as a rare mountainous species and as a symbol of the Virgin Mary. The use of *Myrtus communis* was reported by informants as connected with funerary and cemeteries as symbol of immortality and eternity of life. It is believed that the use of these plants is featured in the mythology, rituals and ceremonies through all ancient civilizations of the Mediterranean region from time immemorial [33,34]. The profound use of plants in religious and cultural practices can clearly reflect the interdependency and harmony between man and wild plants and may support the long term sustainable conservation approaches of the JMBR.

It is worthy to note that as for the indirect uses of the wild plants of JMBR, informants, unless asked, did not well articulate any of indirect non-marketed services of the wild plants of JMBR. In that case, recreation was mostly indicated, whereas other indirect services such as watershed protection, soil protection, habitat support, climate change mitigation and carbon sequestration were rarely indicated. Actually, the importance of indirect non-marketed services to livelihoods is not always easily demonstrated and their share of the total economic value of forests highly varies between ecosystems. Previous analysis of the total economic value of Mediterranean forests revealed that recreation benefits are more important in the countries to the North of the Mediterranean than those to its South and East. Neverthless, direct use values was estimated to constitute around 70% of total measured benefits, with indirect use benefits accounting for another 15% [5]. In JMBR, the recent increased attention of the management body for

the initiation of several ecotourism projects and the establishment of various recreation enterprises have gained solid grounds during the past few years offering substantial income generation opportunities to the socioeconomic wellbeing of locals [21,22]. With the increasing demand for recreational activities and tourism, these services are getting more important. The value of these services of Mediterranean forests has been estimated to range between 2.5 and 11€/capita/visit [7,35]. As for watershed protection, Merlo et al. [5] reported that approximately 40% of the total economic value of Italian forests can be ascribed to this service. Whereas, carbon sequestration constituted 9.03% of the total economic value forest resources in Turkey [29]. Characteristics and maintenance of indirect services of wild plants and ecosystems in the Mediterranean forests are well recognized to be linked to biodiversity and keystone species that are likely to play a vital role in relation to various ecosystem services to support multifunctionality of these forests in providing multiple goods and services to society [7].

Economic importance

The economic analysis of JMBR plant species in the herein study allowed the determination of a span of 21 plant species of high economic importance scoring 1.5 and 2.5 (Table 2). Based on their commercial value and relationship to economic plants, these plants were found to have an actual commersial value or hold the potential for economic opportunities in Lebanon and the region. *Ceratonia siliqua*, *Cichorium intybus, Laurus nobilis, Lilium candidum*, *Malva* sp., *Matricaria chamomilla, Origanum syriacum*, *Populus nigra, Rhus coriaria* and *Salix libani* ranked as the most economically important species scoring the value of 1.5. These were followed by *Capparis spinosa*, *Cercis siliquastrum*, *Ficus carica, Gundelia tournefortii, Melissa officinalis, Nasturtium officinale, Prunus mahaleb,* and *Salvia* sp. scoring the value of 2.0, while *Foeniculum vulgare* and *Rubus* sp. came third scoring the value of 2.5. The economic importance of these plants lies on their actual or potential value-chain as food, timber and industrial materials as well as being a vital pool for plant genetic material for food and agriculture. No doubt that the domestication and cultivation of some of these species has in various countries played a major role in the shift from local wild gathering to farming, and has stimulated the socioeconomic development of communities. With the exception of *Origanum syriacum* which is witnessing a rapidly increasing interests by small-medium hold farmers and may be considered now as a minor crop [18,23,36]. In addition, recent afforestation initiative of *Ceratonia siliqua* and family farming projects of *Laurus nobilis* and *Rhus coriaria*, the high score achieved with most species is mainly a result of the economic opportunities and potential they hold rather than having actual commercial value [23]. The high economic value of the multipurpose tree *Ceratonia siliqua* should be considered in Lebanon particularly when the labor-intensive nature of harvesting and the increasing costs of labor in southern Europe give some advantages to potential producers in developing countries [37,38]. It now falls to nascent industry organizations, agricultural cooperation, and national programs to develop cultivation initiatives of potential crops.

Conclusion

This study illustrates the ethnobotanical importance of 60 wild plants of JMBR reported by local informants to provide significant economic, social and ecological values which are of fundamental importance for local livelihood development and resilience to environmental change. Out of the informants reported species, 21 wild plant species scored high economic importance values represented in their actual or potential value-chain as food, timber and industrial

Plant species	Notes on economic importance	E1
Capparis spinosa L.	Harvested of the wild for its edible flowering buds (pickles) [25]. Recommended for potential value chain action [36].	2
Ceratonia siliqua L.Link	Wild populations frequently harvested for wood and pod molasses production. Very small-scale cultivation and reforestation initiatives. Potential in food, pharmaceutical and cosmetic industries, paper making and tannery.	1.5
Cercis siliquastrum L.	Component of JMBR natural landscape. Subject to recent limited propagation initiatives for ornamental use.	2
Cichorium intybus L.	Commonly harvested of the wild for its edible leaves. Subject to local small-scale cultivation.	1.5
Ficus carica L.	Commonly harvested of the wild for local consumption of fresh and dry fruits [25]. Small-scale cultivation. Potential in food and alcohol industry.	2
Foeniculum vulgare Mill.	Rarely harvested for its edible fresh or cooked leaves, corm and seeds (spice). Subject to local small scale cultivation.	2.5
Gundelia tournefortii L.	Commonly harvested of the wild for its edible young inflorescence heads and leaves. Potential for cultivation.	2
Laurus nobilis L.	Commonly harvested of the wild for its leaves as a spice. Largely grown as ornamental. Propagation initiatives conducted by some local nurseries and NGOs. Potential for it's the leaves (Folia Lauri) and fruits (Fructus Lauri) as spice and medicinal laurel fruit oil (Oleum Lauri).	1.5
Lilium candidum L.	Commonly harvested of the wild for medicinal, religious purposes and perfume production. Potential for cultivation.	1.5
Malva sp.	Commonly harvested of the wild for its edible leaves. Subject to local small-scale cultivation.	1.5
Matricaria chamomilla L.	Intensively harvested of the wild as a medicinal plant, herbal tea and for cosmetics. Potential for cultivation.	1.5
Melissa officinalis L.	Harvested of the wild as a spice, herbal tea, condiment, medicinal plant and perfumes. Potential for cultivation.	2
Nasturtium officinale (L.) R. Br.	Commonly harvested of the wild for its edible leaves. Subject to local small-scale cultivation.	2
Origanum syriacum L.	Intensively harvested of the wild. Recently cultivated with rapidly increasing interests as one of the most edible wild plants in the country [18]. Wild forms protected against overharvesting by the Ministry of Agriculture (Decision 340/1, 1/8/1996).	1.5
Populus nigra L.	Harvested of the wild and small-scale cultivated as sources for timber, shelter belts, pulp and as a street and hedge tree. Small-scale cultivated.	1.5
Prunus mahaleb L.	Propagated in Lebanon for its fragrant fruit stones and as rootsock for cherry [17]. Limited cultivation for its kernels and afforestation initiatives.	2
Rhus coriaria L.	Intensively harvested of the wild to be used as edible spice, tanning of leather and textiles, and also as medicinal product.	1.5
Rubus sp.	Harvested of the wild for its edible fruits and as rootsock for Rubus.	2.5
Salix libani Bornm.	Intensively harvested of the wild. Small-scale propagation activities in protected areas of Lebanon.	1.5
Salvia fruticosa Mill.	Intensively harvested of the wild and exported for its culinary use and pharmaceutical properties. Protected against overharvesting by the Ministry of Agriculture (Decision 340/1, 1/8/1996). Small-scale cultivation initiatives.	2
Salvia sclarea L.	Occasionally harvested of the wild as condiment. Potential for toiletry, perfumery and cosmetics materials production.	2

Table 2: Plant species of actual and potential national and international economic importance in Jabal Moussa Bioreserve.

materials as well as being a vital pool for plant genetic material for food and agriculture. The economic value contained in these species highlights the importance to consider them among the priority species for research and development programs necessary to sustain the local livelihood of traditional societies.

Keeping in view the fast vanishing traditional knowledge, this study documents important information ensuring that future users recognize the contributions made by traditional communities, the current custodians of traditional knowledge. A coherent analytical framework is needed to valuate both the direct and the indirect wide range of services JMBR ecosystem provides to comprehensively assess its contribution to local livelihood and national economy.

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References

1. Millennium Ecosystem Assessment (MA) (2005) A toolkit for understanding and action protecting nature's services. Protecting Ourselves. Island press.
2. TEEB (2010) The economics of ecosystems and biodiversity, synthesis report.
3. Sánchez-Mata MC, Loera CRD, Morales P, Fernández-Ruiz V, Camara M, et al. (2012) Wild vegetables of the Mediterranean area as valuable sources of bioactive compounds. Genetic Resources and Crop Evolution 59: 431-443.
4. Bidak LM, Kamal SA, Halmy MWA, Heneidya SZ (2015) Goods and services provided by native plants in desert ecosystems: Examples from the northwestern coastal desert of Egypt. Global Ecology and Conservation 3: 433-447.
5. Merlo M, Croitoru L (2005) Valuing Mediterranean Forests - Towards Total Economic Value. Wallingford, Oxon (UK), CAB International CABI Publishing.
6. Croitoru L (2007) Valuing the non-timber forest products in the Mediterranean region. Ecological Economics 63: 768-775.
7. Palahi M, Mavsar R, Gracia C, Birot Y (2008) Mediterranean forests under focus. International Forestry Review 10: 676-688.
8. Mouterde P (1966,1970,1983) New Flora of Lebanon and Syria Beirut: Catholic Printing.
9. UNESCO MAB Gobierno De Espana and APJM (2012) Biodiversity assessment and monitoring in the Jabal Moussa biosphere reserve; Final Report.
10. Sattout E (2007) Terrestrial floral diversity in Jabal Moussa: Preliminary Site diagnosis. 1st Site evaluation report presented to JABAL MOUSSA Association Under the Contract Agreement Entitled: 'Baseline Surveys and Preliminary Status Assessment: Flora Diversity in Jabal Moussa.
11. Cook FEM (1995) Economic botany - data collection standard. Prepared for the International Working Group on Taxonomic Databases for Plant Sciences (TDWG) Kew, UK, Royal Botanic Gardens.
12. Euro Med (2006) Euro+Med Plant Base - the information resource for Euro-Mediterranean plant diversity.
13. Phillips O, Gentry AH, Reynel C, Wilkin P, Galvez-Durand BC (1994) Quantitative ethnobotany and Amazonian conservation. Conserv Biol 3: 350-361.
14. Gazzaneo LRS, de Lucena RFP and de Albuquerque UP (2005) Knowledge and use of medicinal plants by local specialists in a region of Atlantic Forest in the state of Pernambuco (Northeastern Brazil) Journal of Ethnobiology and Ethnomedicine 1: 9.
15. Catling PM, Porebski S (1998) Rare wild plants of potential or current economic importance in Canada- a list of priorities. Can J Plant Sci 78: 653-658.
16. Chalak L, Noun J, El Haj S, Rizk H, Assi R (2011) Current Status of Agro-biodiversity in Lebanon and Future Challenges. Gene Conserve 10: 23-41.
17. Chalak L, Elbitar A, Chehade A (2014) Diversity of wild Prunus in the Bekaa province, Lebanon. In: Avanzato D (Eds) Proc First ISHS Symposium on Fruit Culture and its Traditional Knowledge along Silk Road Countries. Acta Horticulturae 1032: 207-213.
18. GEF-UNDP-LARI (2013) Conservation guideline for medicinal and aromatic plants (MAPs) in Lebanon. Mainstreaming Biodiversity Management into Medicinal and Aromatic Plants (MAPs) Production Processes in Lebanon Project. Funded by the Global Environment Facility, implemented by the United Nations Development Program (UNDP) and Lebanese Agricultural Research Institute (LARI), Beirut.
19. Haddarah A, Bassal A, Ismail A, Gaiani C, Ioannou I, et al. (2014) The structural characteristics and rheological properties of Lebanese locust bean gum. J Food Eng 120: 204-214.
20. Batal M, Hunter E (2007) Traditional Lebanese recipes based on wild plants: An answer to diet simplification? Food Nutr Bull 28: 303-311.
21. http://www.afedonline.org/en/inner.aspx? contentID=1031
22. APJM (Jabal Moussa Biosphere Reserve) (2014) Working Together for Conservation.
23. Fao (2016) Non-Wood Forest Product Value Chains in Lebanon.
24. CBI Market Intelligence, Ministry of foreign Affairs (2016) Trends: Natural ingredients for cosmetics in Europe.
25. Chalak L, Sabra N (2007) LEBANON: Second report on the state of plant genetic resources for food and agriculture.
26. FAO (2009) A Global Treaty for Food Security and Sustainable Agriculture International treaty on plant genetic resources for food and agriculture.
27. FAO (2015) National Strategy for Conservation and Management of Plant Genetic Resources for Food and Agriculture in Lebanon 2015-2035. Optimizing the Use of Plant Genetic Resources for Food and Agriculture for Adaptation to Climate Change.
28. Chalak L (2015) National Strategy for conservation and management of plant genetic resources for food and agriculture in Lebanon 38.
29. Pak M, Türker MF, Öztürk A (2010) Total economic value of forest resources in Turkey. African Journal of Agricultural Research 5: 1908-1916.
30. Poyatos N, Gomez L, Martínez V, Cerrillo N, Rodríguez P (2016) Vulnerability assessment to climate change impacts on Quercus cerris var. pseudo-cerris (Boiss.) Boiss Quercus calliprinos webb. and Pinus brutia Ten. populations in Jabal Moussa Biosphere Reserve (Lebanon).
31. FAO (2011) Country Pasture/Forage Resource Profiles.
32. Ministry of Agriculture Strategy (MoA), Agricultural and Rural Development Program (ARDP) and EU (2014) Ministry of Agriculture Strategy 2015-2019.
33. Kandeler R, Ullrich WR (2009) Symbolism of plants: examples from European-Mediterranean culture presented with biology and history of art, JUNE: Lilies. Journal of Experimental Botany 60: 1893-1895.
34. Özkan AMG (2009) A Mediterranean: Myrtus communis L (Myrtle). In: Morel J-P, Mercuriin AM Plants and Culture: Seeds of the Cultural Heritage of Europe. pp: 159-168.
35. Scherrer S (2002) The Loss of recreational use of forest patrimony after the storms of 1999: The case of the Fontainebleau forest. Economics and Statistics 357: 153-171.
36. USAID/LEBANON (2014) Small scale agriculture set market assessment Lebanon industry value chain development (LIVCD) project.
37. Coppen JJW (1995) Non-Wood Forest Products 6 Gums, resins and latexes of plant origin, FAO publications.
38. Batlle I, Tous J (1997) Carob tree, Ceratonia siliqua L. Promoting the conservation and use of underutilized and neglected crops. 17. Institute of Plant Genetics and Crop Plant Research, Gatersleben/International Plant Genetic Resources Institute, Rome, Italy.