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Ecology and Floristic Diversity of Takoucht Massif Chain in Babors (Be-jaia, Algeria)

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ABSTRACT

The flora of the Takoucht forest is rich and diverse. Of the 164 inventoried species, 115 genera belong to 23 botanical families. The Asteraceae (31 species), Fabaceae (22), Poaceae (21), Lamiaceae (20) and Brassicaceae (20) are the best represented families with more than 20 species each. The rate of endemism in 15.85% (26 species) is about 21% of endemic species of Algeria. The number of rare and very rare species has been estimated at 69 taxa, i.e. a rate of 42.07% compared to the flora of the massif. The global chorological spectrum shows a dominance of Mediterranean strain species (76 species). There are also other northern chorological elements such as European (05 species), Euro-Asian (11 species), paleo-temperate (07 species), circum-boreal (2 species), and oro-European (1 species). Other species in the massif correspond to transitional elements between the Mediterranean choral ensemble and neighboring ones such as the Euro-Mediterranean (18 species), the Atlantic (05 species), the Irano-Turanian Mediterranean (1 species), and the Macaronesian-Mediterranean (1 species). There were 42 medicinal plants belonging to 17 families on the basis of 103 field questionnaires showing the use of the medicinal plants. Endemic and rare species have also been inventoried: Sedum acre subsp. Neglectum (Ten) Archang, Doronicumatlanticum (Chabert) Rouy, Veronica roseaDesf, Helianthemumhirtumsubsp. ruficomum (Viv) M, Astragalusarmatussubsp. tragacanthoides (Desf) Mayor., Hedysarumnaudinianum L. (Coss), CentaureainvolucrataDesf., C. parvifloraDesf, C. pungensPomel, Pulicariaarabicasubsp. inuloides (DC) M., ErinaceapungensBoiss, Hydesarumspinosissimumsubsp. spinosissimumBriq, RupicapnosnumidicusPomel, Androsace maxima L., Rhamnusalaternus subsp. myrtifolia (Willd) M., PituranthusscopariusBenth and Hook, SolenanthuslanatusDC., EbenuspinnataL., Senecioleucanthemifoliussubsp. M. poiretianus, DanaaverticillataJanchen, Myosotis collinaHoffm, Ranunculus millefoliatusVahl, Saxifragaveronisifolia Pers., Drabahispanica subsp. djurdjurae var. cladotricha Mayor, Lamiumlongiflorum Ten., Phlomisherba venti L., Smyrniumperfoliatum L., Cotoneaster racemiflora (Desf.) Koch. Viola munbyanaBoiss.andReut., Himanthoglossumhircinum (L.) Spreng., OphrysnumidaDevillers-Terschuren and P. Devillers, Ophrysbattandieri E. G. Camus.

Keywords: Flora, Takoucht, Endemic species, Dominance, Medicinal plants

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INTRODUCTION

Like all countries around the Mediterranean, Algeria has long been committed to the policy of preservation and conservation of biodiversity through the creation of several national parks. Currently, Algeria has eight national parks that encompass all the original landscapes which are the main hot spots. The chain of Babors is a region very remarkable for its biological potential and biodiversity. The exceptional climatic conditions, combined with a varied and rugged geomorphology have contributed as a conservatory refuge endemic species, among them Jebel Takoucht. Green oak cedar, Holly and Kabyle nuthatch have been specifically noted [1]. At the same time, several research projects focusing mainly on the mapping of this phyto-biodiversity were carried out in these "hot spots". Among these works, studies by [2] in Chrea National Park, [3] and [4] in the El Kala National Park, [5, 6] in the Tlemcen National Park, and [7, 8] in the Gouraya National Park can be mentioned.

All of these works have underlined the importance of such an inventory in the rational management of these natural ecosystems. Indeed, several authors have mentioned that the conservation and enhancement of a natural ecosystem requires a good knowledge of its biodiversity [9]. Many of these works in these ecosystems have highlighted the great floristic richness of these environments and panoply of the endemic and / or rare species that must be placed in conservation priorities. They refer to the advanced state of degradation of these natural ecosystems which is attributed mainly to the combined action of man and animals (overgrazing) [10].

In order to make the vascular flora of these natural environments known, in this work it has been attempted to study floristic diversity and quantification through field observations of one of the most biogeographical and ecological ecosystems of the North-East Algerian sector. This is the Takoucht massif, which is part of the small Kabylie sector of Babors (Fig. 1) and is considered the most forested of all Algeria with a rate of 80% [11] This work has filled the gaps existing in the state of current knowledge on the vascular flora of the Takoucht massif. In fact, the known floristic inventory works in the area concerned the surroundings of the massif [12, 13]. The only floristic synthesis works relating to the whole of the northeastern part of Algeria mostly remain very old and undiscounted [14, 15] Other research carried out on certain forest formations of the Massif remain at least very fragmentary [16]. The richness of the diversity of species of medicinal, economic and aromatic interest of this region allows us to propose solutions for their preservation, conservation, and domestication with the objective of the valorization of these resources in support of sustainable development.

MATERIAL AND METHODS

Study area

The Takoucht is located in the center of several links to the chain of Babors: Adrar OuMellal on the East, Djebel or Amaran on the West, the Kherrata massif on the South and DjebelI moulantaour and Adrar N'FAD on the North. The geographical coordinates of the massif are: Latitude: between 36° - 36 '30''. N and Longitude between 05° - 05°06' E. Jebel Takoucht, which was the subject of our study, is one of the links in the chain of Babors. It is a mountainous area with very rugged relief that rises to 1896 meters above sea level, with an area of about 500ha and 14 km as the crow flies from the Mediterranean Sea. The stratigraphic series of the chain of Babors, to which the Takoucht is a part, is schematically composed of three structural units [17] with the Jurassic carbonate formations at their base. The second level consists essentially of limestone pelites and schists, as the highest, corresponding to the Upper Cretaceous, marl-limestone.

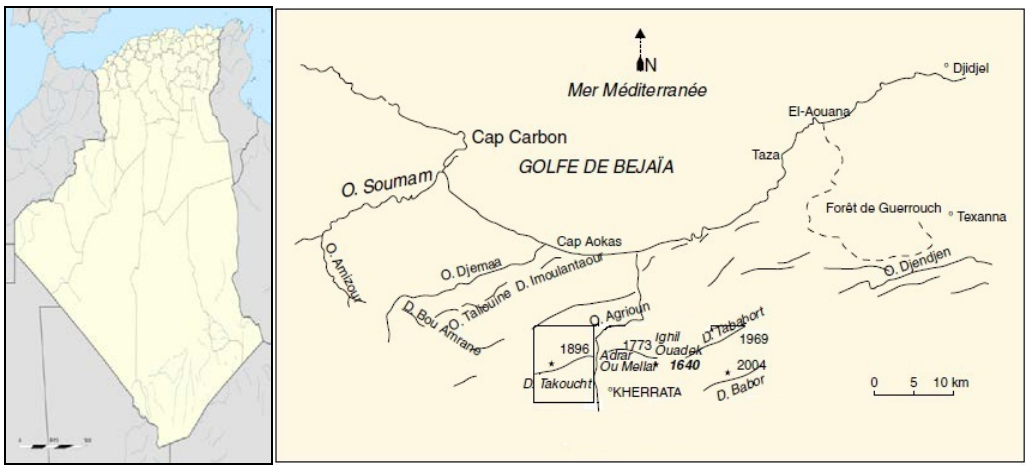


Fig. 1. Localization map of the study area

Djebel Takoucht

According to the rainfall map compiled by the National Agency for Hydraulic Resources [18], the study area was in annual ranges from 880 mm to 1452 mm. The average minimum temperature of the coldest month (January) (m) varied between -1.8 ° C and 2.6 ° C. The maximum temperatures of the hottest month (July) (M) were between 23.9°C and 32.8°C. And the dry period varied from 3 to 4 months.

The rainfall quotient of Emberger Q2 [19] calculated in several stations varies between 100.7 and 198.9 which places the Jebel Takoucht in the bioclimatic stages per wet to cold winter in the northern part, wet cool winter in the mid Slope is a cool winter in the southern part of Djebel [20]. On the phytochorology level, [21] Jebel Takoucht is attached to the sector of Kabylie and Numidian (sub-sector of Little Kabylia), District of Kabylie Baborean Mauritanian Mediterranean area.

These climatic and lithological characteristics determine a rich and diversified flora whose main forest species are: Cedar, which represents more than 60% of the forest area, and the holm oak, 20% as follows [22]: Due to its great ecological plasticity in the mountains, the living cement that connects the forest massifs, appears as the substratum, the bottom on which is detached in more vivid spots that exist in the other species. High matorrals raised whose height is between 2 and 7 m, average matorrals whose height is between 0.6 and 2 m, and low matorrals whose height is less than 0.6 m, which are a very degraded matcher of green oak and low formations lower than 0.30 meters, dominated by hemicryptophytes, herbaceous chamephytes and geophytes, whose seasonal production rate is even more marked than the edaphic drought, and this formation was very common on the ridges a long time ago when the formations based on spiny xerophytes in pads, called "ravaged lawns", were found. [13, 23, 24, 25].

METHODOLOGY

The methodology used to develop the Jebel Takoucht flora study was based on a set of floristic surveys, conducted according to the phytosociological method within the different types of vegetation (forests, scrubland and lawns). Floristically homogeneous surfaces were delineated, taking the most common ecological parameters such as altitude, exposure and slope into account. Vegetation cover, by stratum, was also considered. Thus, 38 floristic surveys were realized. The surface of the surveys varied according to the types of vegetation. It varied between 300 to 400 m^2 for the forest vegetation and between 5 and 10 m^2 at the level of rupicolous vegetation. The surveys were conducted during field campaigns in 2012 and 2013.

The floristic surveys were conducted according to the subjective sampling in all vegetation types of Jebel Takoucht. The collected samples of plant species were determined in the laboratory using different flora [7, 26-28]. The nomenclature of the adopted species was that of [29-31].

The collected control samples of each plant species were deposited in the laboratory of Mohamed Boudiaf University of M'sila. The identified chorological types of the various taxa were attributed according to the consulted indications of the flora. In the analysis of floristic records, special attention has been paid to endemic and / or rare species. Similarly, the analysis of the flora of the study area and the different ethnobotanical works carried out in the surrounding areas of Jebel Takoucht allowed us to highlight an important list of medicinal plants used by the neighboring population.

RESULTS

Specific wealth

The number of taxa counted in Jebel Takoucht was 164 species and the subspecies of 155 genera and 23 botanical families of vascular plants (phanerogams and vascular cryptogams). This number represented approximately more than 5.22% of the total Algerian flora estimated at 3139 species [30]. The phanerophyte species represented about 1.2% of Jebel Takoucht flora, making a total of 37 species. The Asteraceae, Fabaceae, Poaceae, Lamiaceae, Brassicaceae, Caryophyllaceae and Rosaceae were best represented in the Djebel region, with more than 20 species. These families account for nearly 69.51% of Jebel Takoucht's total species richness. These results are consistent with those of [32]. This richness places jebel takoucht among the most diversified ecosystems in the

country, as is the case for all of Little Kabylia, which features have already been reported by [1, 13]. This floristic richness of the jebel is probably due to i) its geographical position that opens directly onto the Mediterranean Sea and therefore exposes it to the maritime influences of the Northwest. ii) The diversity of habitats resulting from climatic and edaphic heterogeneity and (iii) a relatively lower exploitation of the environment comparing to the other ecosystems.

Chorological type

The analysis of the Jebel flora has shown the existence of several phytochoric groups. The most representative has been the Mediterranean with 76 species. This situation remains common to most of Algeria's natural ecosystems [33, 34], and the entire Mediterranean basin [2, 22, 35-37]. This Mediterranean ensemble has been subdivided into several subsets: The Mediterranean Ss (37 species), the West Mediterranean (17 species), the Ibero-Mediterranean (07 species), the Oro-Mediterranean (05 species), the Mediterranean centers. (1 species), and Eastern Mediterranean (8 species). Northern (northern) chorological species have been relatively well represented in Jebel Takoucht, such as those belonging to the European element (23 species), Eurasian (11 species), paleo-temperate (05 species), circum-boreal (02 species), oro-European (18 species) and Atlantic (05 species). Other species correspond to transitional elements between the Mediterranean choral ensemble and the neighboring ones such as the Euro-Mediterranean (30 species), the Mediterranean-Iran-Turanian (01 species), the Macaronesian-Mediterranean (with 01 species).

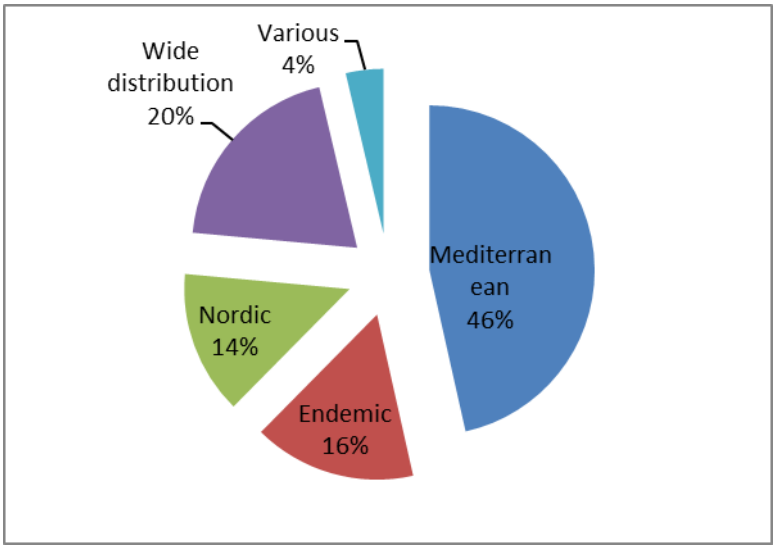


Fig.2. Chorological spectrum of DjebelTakoucht..

Analysis of endemism

Within the endemic species, it has been noted the presence of 26 taxa, a rate of 15.85% compared to the total species of Jebel Takoucht, and 4.73% compared to the total endemic flora of the country estimated at 549 species [33] and nearly 1.01% compared to northern Algeria [1]. This rate of endemism is relatively average compared to that recorded in several parks of central and eastern Algeria such as that of Belezma (Batna) with 32 species, Gouraya (Bejaia) with 28 species [38], Djurdjura with 35 species [39] and Kala (Taref) with 75 species [3]. This endemic flora of Jebel Takoucht consists mainly of Algerian endemic species (10 species), North African (12 species), Algerian-Moroccan (03 species), Algero-Tunisian (01 species). Asteraceae and Lamiaceae represent the families with the highest number of taxa endemic to Jebel Takusht respectively with 4 species and 03 species, and a rate of 15.387% and 11.15%.

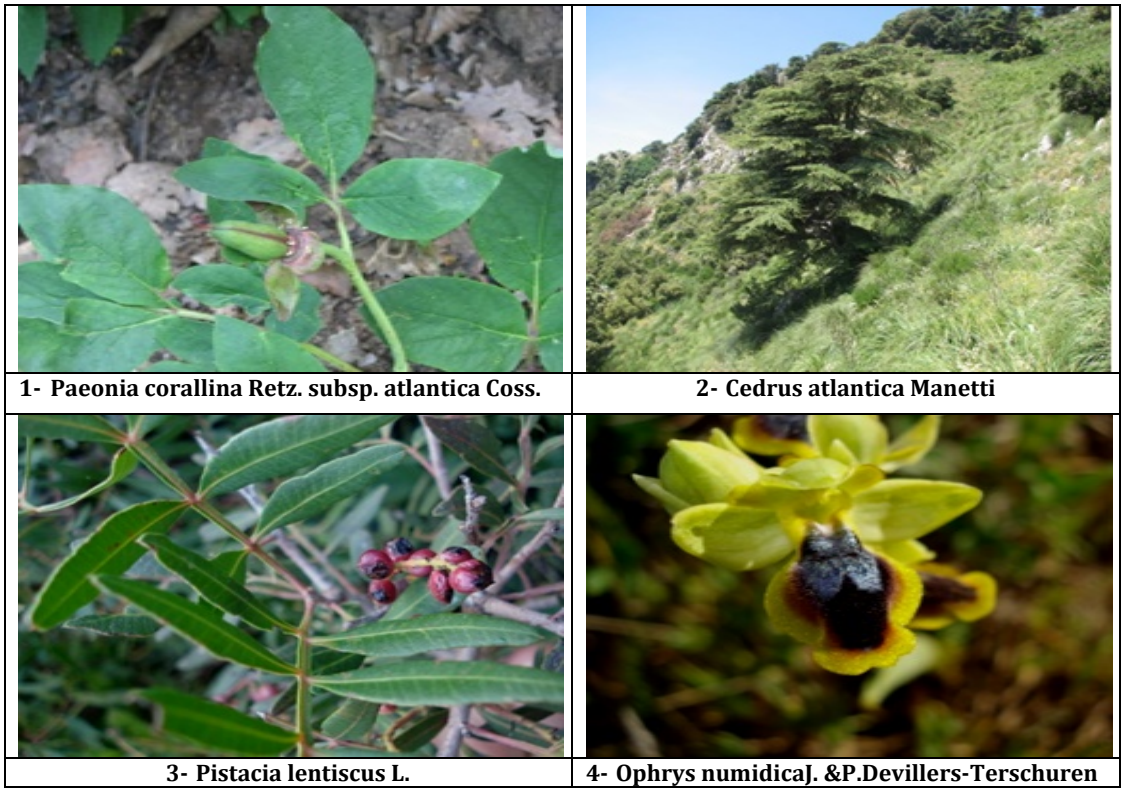
Analysis of rarity

The scarcity analysis, based on data from [29], identified nearly 69 species reported as rare or very rare. With these data, Jebel Takoucht records a rarity rate of 42% of all the taxa inventoried in the Massif and nearly 55% compared to the rare species selected for Northern Algeria and about 3.7% compared to

the entire national territory [37]. Compared with the entire phytogeographical sector of small Kabylia, which has about 487 rare species [1], Jebel Takoucht hosts around 14.16%. Among the 129 Algerian taxa included in the red list of the International Union for the Conservation of Nature (1980), 09 species are found in Jebel Takoucht distributed over the two types of the studied formations (Table 2 and 3).

There are 42 herbal remedies based on 103 records that have shown the use of these plants in medicine. Endemic species included Coronillavalentina L. subsp. speciosa (Uhrova) Greuter&BurdetViciaochroleuca.subsp. baborensis (Batt &Trabut) Greuter&Burdet; Paronychia arabica (L.) DC subsp. aurasiaca (Webb.)Mayor and WeillerCampanula trachelium L. subsp. mauritanica (Pomel) Quézel.Origanum vulgare L.subsp.glandulosum (Desf.LetswaartThymus munbyanus Wood &Reut subsp. Coloratus (Boiss& Reuter) Greuter and BurdetAquilegia vulgaris L. subspcossoniana (Mayor &Sennen) Dobignard; Onosmafastigiata (Br. Bl.) Lacaita subsp. Mayor mauretanica and rare as Hieraciumjuranum Fries, IsatisdjurdjuraeCoss.

Monotropahypopitys L., Neottia nidus-avis (L.) L. C. Richard M., Primula acaulis (L.) L. subsp. atlantica (Mayor &Wilczek) Greuter&Burdet, Rhamnusalpina L., Rhamnuscathartica L.,RibespetraeumWulfen, Satureja grandiflora subsp. baborensis (Batt.) Mayor, Saturejajuliana L., Viburnum lantana L.



1- Paeonia corallina Retz. subsp. atlantica Coss. | **2- Cedrus atlantica Manetti**

3- Pistacia lentiscus L. | **4- Ophrys numidicaJ. &P.Devillers-Terschuren**

Fig. 3. Rare Plants in DjebelTakoucht (Photos: [2])

Table 1. Number of rare and endemic species of botanical families

Families	Number of endemic	Percentage (%)	Number of rare species	Percentage (%)
Asteraceae	04	15,38	16	13,33
Lamiaceae	03	11,15	07	5,83
Poaceae	02	07,69	11	9,16
Caryophyllaceae	02	07,69	09	7,5
Brassicaceae	02	07,69	12	10
Fabaceae	02	07,69	13	10,83
Scrofulariaceae	01	3,84	04	3,33
Apiaceae	01	3,84	08	6,66
Ranunculaceae	01	3,84	05	4,16
Crassulaceae	01	3,84	03	2,5
Campanulaceae	01	3,84	01	0,83
Fagaceae	01	3,84	-	-
Berberidaceae	01	3,84	02	1,66
Geraniaceae	01	3,84	02	1,66
Thymelaeaecea	01	3,84	02	1,66
Violaceae	01	3,84	01	0,83
Cistaceae	01	3,84	-	-
Total	26		69	100

Medicinal plants

Out of the 103 field questionnaires, 42 species belonging to 17 families, and having a medicinal interest in the study area were counted. The development of the research in the field of pharmacology, and the identification of the active ingredients of the species, will allow the creation of an economic activity around the use of plants in an organized environment respectful for the safeguarding of the flora. As in most Algerian regions, the inhabitants of Jebel Takoucht use some of these species in traditional medicine which are marketed by herbalists (AsphodelusmicrocarpusSalzm. & Viv., Asparagus officinalis L., L., CeterachofficinarumLamk, Crataeguslaevigata (Poiret) Dc, CrataeguslaciniataUcria,Menthapulegium L., Menthaspicata L., Inulaviscosa L., Mentharotundifolia L., Opuntiaficusindica (L.) Mill., Ficuscarica L., Punicagranatum L. , Juniperusoxycedrus L., Nerium oleander L., Teucriumpolium L., Thapsiagarganica L., Ulmuscampestris L., Osmundaregalis, L., Taxusbaccata L., Arum italicum Mill., Ruscusaculeatus L., Urticadioica L., Papaver rhoeas L., Alliariapetiolata (M. Bied.) Cavara & Grande., Paronychia argentea Lam., Stellaria media (L) Mill.

Many plants have been the subject of phytochemical and ethnobotanical studies in North Africa in general, and in Algeria in particular. The majority of these plants are in the floristic list of the study area as: BerberisHispanicaBoiss. & Reut., BupleurummontanumCoss, Cynodondactylon L., Inulacrithmoides L., Inulaviscosa L., OriganumglandulosumDesf., Olea europaea L., Pistacialentiscus L., Salvia verbenaca L., Teucriumpolium L. Ricinuscommunis L. [40].

Table 2. The rarity rate by chorological origin

Chorological origin	Total number of species	Percentage rate (%)	Degree of Rarity	
			Total species rare & very rare	Rate in Percentage (%)
Mediterranean	76	46,33	35	46,05
Mediterranean	37			
West-Mediterranean	17			
Ibero-Mauritanian	07			
Oro-Mediterranean	05			
Center-Mediterraean	01			

Eastern Mediterranean CircumMediterraean	01 08			
Endemic	26	15,85	05	19,23
Algerian endemics	10			
North African	12			
Algeria and Morocco	03			
Algeria and Tunisian	01			
Nordic	23	14,02	11	47,82
Eurasian	11			
European	05			
Paleo-temperate Circum-boreal	05 02			
Wide distribution	33	19,78	16	48,48
Euro-Europeans	18			
Atlantic-Mediterranean	05			
Macaronesian-Mediterranean	02			
Eurasian-Mediterranean	01			
cosmopolitans	05			
Iran-touranian Mediterranean	01			
Macaronesian-Eurasian	01			
Miscellaneous	06	3,68	2	33,33
Total	164	100	69	

The anarchic exploitation of species known for their therapeutic virtues constitutes a risk for their survival. Some species are in danger of extinction because of their overexploitation (abusive uprooting). This is the case of Lamiaceae species that are torn up with their roots to be sold in towns and villages in the regions such as: Teucriumpolium L., Mentharotundiflolia L., OriganumglandulosumDesf [41, 42].

CONCLUSION

The analysis of Jebel Takoucht's floristic diversity has shown its great richness and ecological and phytogenetic originality. These data have justified its classification with all the little Kabylie as “hot-spot” of the northern part of Algeria. However, Jebel Takoucht, despite enjoying the legislative protection, like most Mediterranean natural ecosystems, is the subject to worrying degradation. In fact, anthropogenic activities (anarchic harvesting of wood, exploitation of timber, uprooting of plants of interest, etc.) and uncontrolled grazing have been seriously prejudicial to this specific wealth. To address this issue and maintain Jebel's ecological integrity, an integrated strategy for conserving this biodiversity must have been put in place. This strategy must focus first and

foremost on the forest species of Jebel, which by their uniqueness constitute the essential framework of this natural ecosystem. These include cedar (CedrusatlanticaWilld), holm oak (Quecusrotundifolia L) and Taxusbaccata. Indeed, these cedar and oak forests are the main forest formations of Jebel Takoucht, and host in their floristic procession of several species endemic or / and rare of the genera Cyclamen, Corydalis ... etc. Jebel Takoucht also contains several rare and sometimes endangered species to which special attention must be paid. Some of these rare species deserve to have their conservation status reviewed, and are therefore needed to be included in the IUCN Red List of the International Union for the Conservation of Nature, particularly including Galiumodoratum (L) Scop, Saturejajuliana L., Viburnum lantana L., Hieraciumernest Mayor, Convolvulus dryadum Mayor, Stellariaholostea L, Chrysanthemum fontanesii L., BupleurummontanumCoss, and Sedum pubescensVahl.

Table 3. The rare and endangered species of Jebel Takousht

Species not listed in the IUCN Red List	Species listed in the IUCN Red List
Chrysanthemum fontanesii L. Sedum pubescens Vahl.	Teucrium atratum Pomel. Phlomis bovei de Noe.
Bupleurum montanum Coss.	Saxifraga numidica Maire

Hieracium ernest Maire	Teucrium kabylicum Batt.
Galiumodoratum(L) Scop	Fedia sulcata Pomel.
Convolvulus dryadum Maire	Carum montanum (Coss & Dur.)Benth.
Stellaria holostea L. Arabis doumetii Coss Teucrium atratumPomel Pimpinella battandieriChabert Cedrus atlantica Manetti Sorbus aria(L.)Crantz, Taxusbaccata L.	Arabis doumetii Coss. Moehringia stellaroides Coss. Sedum multiceps Coss & Durieu

The multiplication of ethnobotanical studies on a national scale will make it possible to better know the potentialities in this field, evaluate the risks resulting from the use of certain poisonous plants, and adopt a new approach of management for safeguarding and preservation of natural resources [2, 37].

A large number of spontaneous species in the study area have potential value for medicine and feed as fodder. The establishment of cultivation processes, of these species, instead of anarchic gathering, can improve the income of the local populations while guaranteeing the conservation of the floristic diversity. The cultivation of these plants of economic interest and their commercialization will undeniably increase the income of the populations [2, 7].

Indeed, for the extraction of the active ingredients, phytochemists need a certain amount of the plants, parts of the plants or the whole plant, in both cases the plants are harvested whole during their flowering and fruiting. This necessitates the creation of cultivation plots of medicinal plants selected from the floristic lists established according to the inventories. The culture is replacing the picking. In Algeria, the market for medicinal plants is uncontrolled [41]. Considering the different uses of these plants, the regulation seems necessary.

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